

MARSH AND WATER MANAGEMENT PLAN

BACK BAY NATIONAL WILDLIFE REFUGE

VIRGINIA BEACH, VIRGINIA

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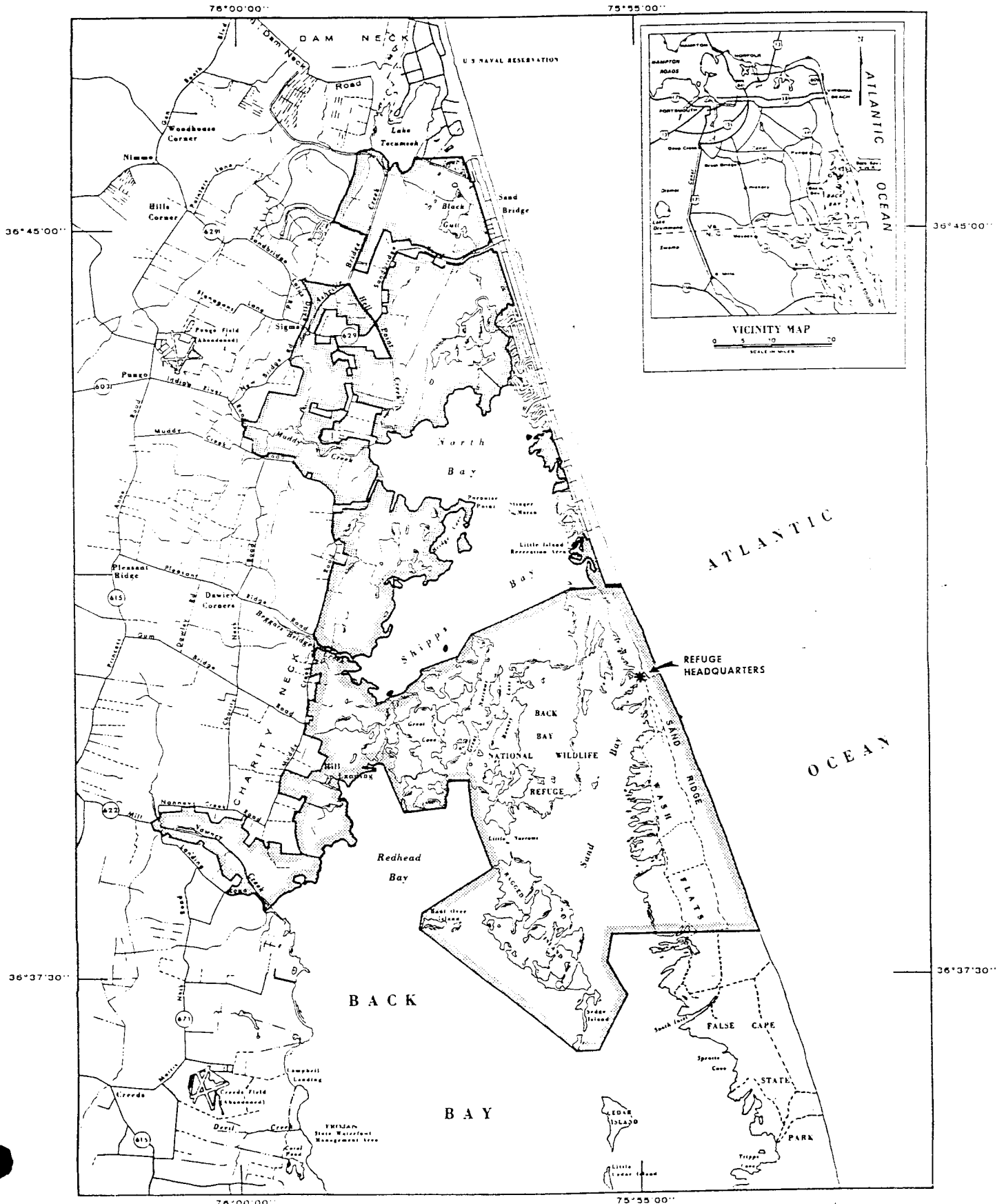
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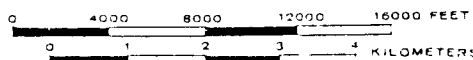
UNITED STATES
DEPARTMENT OF THE INTERIOR

CITY OF VIRGINIA BEACH, VIRGINIA

UNITED STATES
FISH AND WILDLIFE SERVICE



COMPILED IN THE DIVISION OF REALTY
FROM SURVEYS BY U.S.G.S. AND U.S.F.W.S.



MEAN
DECLINATION
1980

NEWTON CORNER, MASSACHUSETTS, April 1989
REVISED, MARCH 1990

I. INTRODUCTION

Back Bay National Wildlife Refuge (NWR) is located in the southeastern corner of Virginia Beach City, Virginia. The Refuge was established by Executive Order No. 7907 on June 6, 1938 "...as a refuge and breeding ground for migratory birds and other wildlife." An additional 4,600 acres of open bay waters within the Refuge boundary were closed to the taking of migratory birds in 1939 by Presidential Proclamation.

The Refuge currently consists of 7,700 acres within a recently approved acquisition boundary of 10,929 acres. The original 1938 purchase consists of 4,589 acres of beach, dunes, fresh and brackish marshes, and woodlands located along a thin strip of coastline typical of barrier islands found along much of North America's Atlantic Coast. In 1990, the first lands acquired since 1938 were purchased. Between 1990 - 1993 more than 3,100 acres of additional habitat were acquired.

The barrier beach portion of the Refuge extends 4.2 miles along the Atlantic Ocean shoreline and is bordered on the north by the City's Little Island Recreational Area, and on the south by False Cape State Park. The North Carolina border is approximately six miles from the southern boundary of the Refuge.

"The 'purposes' of Back Bay Refuge are as follows:

'...as a refuge and breeding ground for migratory birds and other wildlife.' Executive Order 7907, dated June 6, 1938.

'...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.' 16 USC 715d (Migratory Bird Conservation Act).

'...the conservation of wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions...' 16 USC 3901(b). 100 Stat.3583 (Emergency Wetlands Resources Act of 1986)."

Refuge objectives can be found in Section C, of the Station Management Plan. Objectives #4 and #5 detail the need to provide suitable habitats for high priority, migrating and/or nesting ducks, geese, shorebirds and wading birds. These two objectives specify that approximately 60% of impounded wetlands will be managed as wintering dabbling duck habitat (percentage to be refined over time); and approximately 40% of impounded wetlands will be managed as migrating shore and wading bird habitat (percentage to be refined over time).

Objective #1 details the need to develop and operate an efficient data management system for Refuge wildlife/habitat data. Such an upgraded system will need to incorporate a GIS system and related computer hardware and software, to be effective.

All of the recommendations contained in this plan serve one or more of the above objectives. Waterfowl and shorebird use have increased significantly in the postdunal and high marsh habitats since Refuge establishment, because of impoundment development, land-use practices and other wildlife management techniques. The degree to which the planned objectives are met depends on the future management and continued development of the Refuge. Marsh and water management plays a critical role in Refuge habitat enhancement efforts.

Throughout this plan the expressions NGVD and MSL are used synonymously to refer to water levels measured from zero, National Geodetic Vertical Datum.

II. PHYSICAL FEATURES & HISTORY

Part I of the Station Management Plan outlines the general, physical features of the Refuge, including the lands of the barrier spit on which the 880 acres of ten impounded marshes, or "Wetland Management Units" (WMUs), are located.

The major physical feature of these WMUs is the dike system. This dike system originally rose approximately three feet above the marsh surface (four feet-NGVD) and extended to the north and south, roughly parallel to the Back Bay shoreline. Several east to west crossdikes divided the WMUs into Units A, B, C, D, and E. A pump station and several water control structures were located throughout the dike system. The East Dike roughly paralleled the West Dike, by extending north to south. Parts of it were built atop old dike segments and other parts on higher, natural elevations. The East Dike marked the eastern edge of the existing impoundment system, although precipitation could be held between the east dike and the back dunes of the beachfront. Appendix B1 illustrates the above described dikes and units. This infrastructure has remained in operation to the present.

Between 1989 and 1993, further improvements to this system were developed and implemented. These improvements included the construction of C-Storage (45 acres) and B-Storage (13 acres) Units, within the southern end of Unit C and the western side of Unit B. These storage units are meant to function as water reservoirs, so that water will always be available to charge other units. The partitioning off of portions of Units B and C reduced them to 95 and 190 acres respectively (including acreage lost to

new dikes). Other improvements include the installation of ten new water control structures, to facilitate the movement of water from the storage units to other impoundments, or to drain them; the raising of the West, South and East Dikes to a minimum of 6 feet NGVD/MSL); and formation of the easternmost G, H and J Units, through construction of two bisecting dikes (Ref. Appendix B1). Acreage figures for all current management units can be found in Appendix A3.

The Long Island vicinity to the west comprises WMU K. This unit possesses two agricultural fields that are currently cooperatively farmed to ladino clover and wheat, for goose browse. Other crops (corn and rye) are possible in the future.

Scattered throughout the bay, to the west of the management units are the Ragged Island complex and numerous unnamed marsh islands. These have been collectively designated WMU L. Appendix B2 illustrates these two more remote, management units.

Land acquisition is ongoing on lands within the new Refuge acquisition boundary to the north and west, on the mainland. These new acquisition lands comprise WMUs L (North Bay Unit), M (Beggar's Bridge Unit) and N (Nawney Unit), and total approximately 5,600 acres.

Management of the above WMUs will be governed by revised Fire, Inventory, Pest Control, etc. Management Plans and Programs.

III. BIOLOGICAL FEATURES

A. Vegetation

Plant species presence on-Refuge is controlled by water table depth, seed bank presence, wind and salinity. The Biological Resources section of the Station Management Plan provides a good description of Refuge habitats and their accompanying flora. Appendix A1, illustrates the frequency (% of total number present) of plants on the permanent vegetation transects for the three major WMUs in 1985.

The Back Bay/Currituck Sound area traditionally overwintered a high percentage of the Atlantic Flyway's waterfowl. Minimum industrialization, little development, and the resulting clear shallow water supported large acreages of such high value, submergent waterfowl food-plants as: widgeongrass (Ruppia maritima), sago pondweed (Potamogeton pectinata), southern naiad (Najas flexilis), wild celery (Vallisneria americana), and muskgrass (Chara spp.).

In 1965, the first Eurasian milfoil (*Myriophyllum asiatica*) infestation was noted in Back Bay. By the end of that year, it had spread into Currituck Sound, North Carolina. The milfoil continued to spread throughout both areas, and was abundant in both the bay and sound by 1970 (Florschultz, 1971). With the introduction and spread of Eurasian milfoil, waterfowl numbers began to increase significantly. Wintering waterfowl, including Canada geese, widgeon, gadwall, pintails and scaup, were observed feeding in the dense milfoil beds (Florschultz, 1971). During the early 1970s, Refuge employees noticed an apparent spread of sago pondweed, redheadgrass, widgeongrass, naiad, and wild celery, that was presumed due to the stabilization of the bay bottom by Eurasian milfoil (Florschultz, 1972).

The bay and sound vicinities still maintained relatively good SAV species diversity and abundance through the mid-1970s. However, by 1982, SAV species diversity, and abundance had significantly diminished. Deteriorating water quality and increased salinity from saltwater pumping, was suspected to be the cause. Wintering waterfowl populations correspondingly declined.

B. Wildlife

Back Bay NWR principally serves as a wintering area for migratory birds, including waterfowl. As such, emphasis is on providing wintering populations with sufficient food and roosting areas, in order that they return to their breeding grounds in the spring, in the best possible condition. The Refuge also strives to provide for the needs of migrants during the spring and fall migrations, as well as nesting migratory birds. A general listing of migratory birds in these three groups that utilize Refuge areas regularly, is in Appendix A4, and the Biological Resources section of the Station Management Plan.

Two hundred and eighty-eight species of migratory birds regularly use Back Bay NWR each year. All of these species use Refuge wetlands to some extent. The listed species, however, will be most affected by marsh and water management practices.

Common salt and brackish water fish found along the oceanfront and bays are also discussed in the Station Management Plan.

Common fresh-water fish within refuge impoundments and other wetlands include: large-mouthed bass, bluegill, pumpkinseed, white perch, gambusia, killifish, carp, blue-spotted sunfish, shiners and darters. Fisheries Assistance Office (FAO)

Project Leader Gary Swihart (Gloucester Point, VA) conducted electrofishing sampling during the spring of 1992, within B, B-Storage, C and C-Storage Pools. The intent of these surveys is to obtain a fish population and distribution estimate for each pool, so that fishery management concerns can be addressed. Future plans call for regular surveys of WMU fish populations so that migratory bird prey species are better understood and managed. The spring surveys provided Refuge staff with the opportunity to see firsthand that a significant predator and prey fish populations exist within the surveyed pools. A seven-pound largemouth bass was retrieved from the C-Storage Pool during one survey day.

Common reptiles and amphibians inhabiting the Refuge area are: the threatened Loggerhead sea turtle, the slider, painted and snapping turtles; northern water, hog-nosed and black snakes, the black racer, water mocassin (cottonmouth) and green snake; bull, southern leopard, and wood frogs, spring peepers, green tree and chorus frogs; toads, and several salamander species.

A primary food source of migratory birds and fish of Back Bay Refuge are various benthic invertebrates. These include numerous insect larvae (beetles and flies), earthworms, snails, clams and crustaceans (Isopoda, Amphipoda and Decapoda) found in Refuge impoundments. The most commonly collected invertebrates in this area include midge larvae (Chironomidae) and scuds (Amphipoda). From the migratory bird management perspective, midge larvae (bloodworms) constitute one of the most abundant, and therefore important, benthic food resources.

It is the goal of this Refuge and in accordance with the North American Waterfowl Management Plan, to continue to provide habitat for all migratory species in concert with the population and distribution objectives of the Atlantic Flyway Council. In the face of ever-increasing pressure on Back Bay Refuge, strong management commitments must be made for this Refuge to continue to function as a viable link in the Atlantic Flyway.

C. Water Quality

The decline in SAV in the bay habitats within and around the refuge, during the late 1970s and early 1980s, indicated a problem. Water quality degradation was suspected, since the City of Virginia Beach was experiencing rapid growth in the northern and western portions of the Back Bay watershed. Turbidity problems in the water column were apparent; but, whether they were the cause of SAV losses, or the result of

their absence could not be determined. Significant silt "plumes" are visible from the air, at the mouths of several western waterways feeding the bay after severe rain events.

Many local citizens, politicians, city planners, and some biologists, attributed the decline in SAV diversity and abundance to stabilization of the beach dunes by the Civilian Conservation Corps sand fencing project of the 1930's. That project achieved the desired objective of forming large dunes along the beachfront that stopped the ocean from overwashing into the bay. The lack of ocean overwash into the bay system reduced its salinity over time, until the waters were almost fresh and no longer strongly brackish.

This "salinity theory" supported the idea that increased salinity levels caused by ocean overwash resulted in lower turbidity levels due to the flocculation of suspended solids around salt particles. Laboratory tests seemed to confirm this theory. However, in the field, the bond between salt and suspended solids was so weak that any disturbance, such as wind-induced wave action, broke it.

In 1964, the City of Virginia Beach began pumping sea water into the Back Bay system at Little Island City Park, immediately north of the Refuge. The pumping program was intended to satisfy "salinity theory" proponents. Although the City did not monitor the Bay's water quality during the pumping program, the Refuge and State of Virginia did, at a total of 22 locations.

The City of Virginia Beach continued to favor salt water pumping as a cure to the bay's problems until 1987, despite results of a recent study (Roy Mann Associates, Inc., 1984) that stated: "Water clarity is determined by water color (clear, brown) suspended soil particles, and phytoplankton growth. Back Bay water clarity has been an area of concern for many years. The lack of vegetation in the Bay is often attributed to the lack of water clarity. The decision to introduce salt water to the Bay in 1964 was predicated on anticipated improvements in water clarity which in turn would result in increased growth of vascular vegetation."

"Considerable statistical analysis conducted on the salinity and turbidity data revealed no correlation between the two parameters. Even during August 1983 when salinity in North Bay was the highest it has ever been, no correlation was found. The lack of correlation is not surprising since a large change in turbidity can be observed as daily wind and wave conditions in the Bay change. Additionally, when clarity was greatest from 1975

through 1978, the salinity ranged from 1.3‰ SS to 7.4‰ SS." (SS = Sea Strength). (It is interesting to note that during 1975 through 1978 the saltwater pump was frequently out of commission.)

The above conclusion is supported by the observations of former Back Bay Refuge Manager Carl Yelverton. In 1958, he wrote, "Note that the two northern bays, the least salty of the five, supported the greatest amount of plant life and had the clearest water." (Yelverton, 1958).

The U.S. Fish & Wildlife Service (Sincock, 1966) summarized the salinity issue as follows:

"Salinity has had important effects on the environment.... however, the primary factors adversely affecting aquatic plant production have been turbidity and siltation."

In September of 1987, the Virginia Department of Game & Inland Fisheries withdrew their yearly commitment of \$150,000 to the City of Virginia Beach's saltwater pumping program. The program ceased shortly thereafter.

The turbidity issue remained unresolved and not completely understood by the Refuge and the local Ecological Services (ES) Office of the U.S. Fish & Wildlife Service, in Gloucester Point, VA. Increased water monitoring stations were set up by Refuge volunteers and staff during 1991.

Information was passed on to the federally-funded Albemarle-Pamlico Estuarine System (APES) program that operated out of East Carolina University, in North Carolina. APES supports and trains the "Citizens' Water Quality Monitoring Network"; a network of citizens who maintain water-monitoring stations within the Albemarle-Pamlico Estuarine system, and provide weekly water quality data to APES staff at East Carolina University. The Refuge became a more active participant in the APES program in 1991.

During late 1990, Back Bay NWR and the FWS-ES Virginia Field Office developed the "Back Bay Initiative" (Initiative). This Initiative was proposed as a multi-year initiative to address water quality issues in the Back Bay vicinity of Virginia. The overall objectives are to:

1. Review water quality, land use, and biological data pertaining to Back Bay and northern Currituck Sound for the purpose of evaluating historic and present day water quality trends, land use patterns, and ecosystem impacts.

2. Establish and coordinate a communications network with Federal, State and local government agencies and private conservation groups and citizens to encourage participation efforts to protect and enhance water quality in Back Bay.
3. Establish and coordinate a scientific workgroup to evaluate water quality issues in Back Bay and subsequently determine what scientific data are necessary to support efforts to improve water quality.
4. Conduct scientific studies to investigate the impacts from contaminants such as pesticides, herbicides, nutrients, and sediments to natural resources in the bay.

In 1991, the U.S. Fish & Wildlife Service conducted sediment bioassays to evaluate the pesticidal impacts on the bay, by determining the relative toxicity of sediments in the bay. Results from these assays did not establish that the sediments were toxic.

In 1993, the Service commenced monitoring nutrient and turbidity discharges into the bay during storm events, at five "feeder estuaries" that empty into the western side of Back Bay. Two additional "control" stations further east, monitor the more pristine waters of Back Bay Refuge. Participation from affected agencies with land-holdings in the area are contributing to the overall effort to identify and resolve water quality problems in the watershed.

IV. WATER MANAGEMENT PLANNING

The sections that follow are meant to be generic in nature. The intent of this plan is not to provide specific methods for accomplishing each recommendation. This plan is meant to provide managers with a marsh and water management framework for the next five to ten years. Specific goals and methods will be dictated by the Annual Marsh and Water Management Program. "Water Management Units" (WMUs) and "pools" are synonymous.

The existing 8.5 miles of dikes average 12 feet in top width, with a 3:1 dike slope. Bottom elevations were obtained from 1988 U.S. Fish & Wildlife Service Engineering maps for A, B, B-Storage, C, and C-Storage Pools. Bottom elevations for D, E, G, H & J Pools have not yet been developed by the Fish & Wildlife Service, so detailed topographic maps developed by the City of Virginia Beach in July, 1990, were used. However, the City maps require ground-truthing by Fish & Wildlife Service surveyors.

A general description of the current water management complex at Back Bay NWR follows: Soils in the pools are compact and very sandy, with occasional clay lenses. Deeper silty-mucky layers are also found in the original, older A, B, C and E WMUs. The newer "dune pools" (G, H & J) further to the east, consist of looser, sandy soils with little organic content.

A. Unit Descriptions

1. **WMU A (A-Pool)**

WMU A is the southernmost and largest impoundment. It contains 215 acres, 160 of which are emergent wetland, 40 - upland, and 15 - wooded swamp. This unit consists principally of marshes at 1.5' mean sea level (msl) or above. The highest ground is located along the northwestern side, and the lowest in the southeastern corner. A-Pool currently has the best management potential for both waterfowl and shorebirds.

Central areas of the pool contain vigorous stands of saltmarsh bulrush, saltmeadow hay, spikerush, water hyssop, cattail, and black needlerush. Sixty acres of dense black needlerush was disced during November of 1992, to make way for more desirable waterfowl habitat. Higher elevations contain some phragmites, waxmyrtle and live oak. A small area of bottomland mixed hardwood and softwood forest exists on the northwestern side of this pool, that is predominantly red maple, loblolly pine, live oak, and black cherry, with a few pond pines. Other edge/interface areas support pondweeds, millets, beggarticks, red-rooted flatsedge, three-square, and saltmeadow cordgrass.

A total of five water control structures (WCS) were installed in the dikes forming the periphery of this pool, during 1992 and 1993, as part of the Refuge Impoundment Rehabilitation Project. These structures provide better management capabilities for A-Pool water levels. Unless otherwise indicated, all WCSs are of the "flashboard" type, with 24" diameter aluminum corrugated metal pipes (CMP). Their descriptions follow (Ref. Appendix B1 for map locations):

#01 - This is a screw-gate type of WCS, with two flap-gates on the outside ends of the two 24" pipes. Each of the two pipes are 32' long with an invert of 1.0' msl. This structure is located in the south dike, and serves to drain A-Pool into the bay.

#02 - One pipe, 36' long, with a riser height of 4', and an invert of 1.3'msl. Located in the A-Pool south dike. This structure is meant to provide water to the East Pool of False Cape State Park.

#03 - One 36' long pipe, with a riser height of 4' and an invert of 1.0'msl. Located in the east dike, this structure drains the higher-elevation J-Pool into A-Pool. It can also be used to charge A-Pool when no other water is available.

#04 - One 36' long pipe, with a riser height of 4', and an invert of 1.0'msl. Located in the A/B Cross-dike, this structure is meant to drain B-Pool into A-Pool.

#05 - Three pipes, each 48' long, with a riser height of 6', and an invert of 1.0' mean sea level (msl). Located in the A/B cross-dike, the purpose of this structure is to charge A-Pool, by flowing water from B-Storage Pool into A-Pool.

A diagonal GEMCO-ditch was excavated in A-Pool during August 1993, that runs from the southeast to the northwest, between WCSSs #02 and #05 (Ref. Appendix B4). Two other ditches, along the eastern and western sides of A-Pool were also dug (Ref. Appendix B4, Map #10). These ditches are approximately 5.0' wide at the surface, 1.5' wide at the bottom, and 3.0' deep. They are intended to diversify the bottom contour and allow water flow to reach some of the drier portions of this pool during low water periods. They were dug with a GEMCO H-150, self-propelled ditching machine. (The GEMCO only dug 5.0'X 1.5'X 3.0' sized ditches; future references to "GEMCO-dug ditches" will be of this standard size.) The GEMCO ejects spoil to a distance of 100 yards to either side as it ditches, making deposition nearly immeasurable. The ditches will better circulate water, throughout the pool, while also providing additional bottom edge habitats and deeper water for migratory bird and forage fish species. Such ditching will also serve as new acreage to hold water during draw-downs, and provide additional habitat diversity during the spring and summer.

The eastern side of A-Pool contains a narrow strip of Lilialeopsis carolinensis (Carolina lilialeopsis), within an old heavy equipment trail. This plant species has been proposed as a rare and threatened species in Virginia, by the State Division of Natural Heritage, who also refers to it as Lilialeopsis attenuata (Carolina lilialeopsis). It has a documented presence there for the last 10 - 15 years.

Recent migratory bird use of A-pool is described in Section IVB.

2. WMU B (B-Pool)

This unit is the middle pool of the three original impoundments. It consists of approximately 100 acres, of which 96% are emergent wetlands. Bottom elevations average 1.3' - 1.5' msl. About 5 acres on the northeastern edge of the pool were "land-leveled" in 1985 to increase the amount of available wetland habitat. This area now has a ground elevation of 1.7' and is reverting to emergent wetland as a result of winter flooding. The highest ground is located on several tiny "islands" in the mid-eastern part of B-Pool; the lowest (~0.5' msl) is in the southeastern corner.

Small waxmyrtle and live oak "islands" are present along the eastern side of the pool. Phragmites is present in an area along the A/B crossdike. This unit contains excellent stands of three-squares and Bacopa, and scattered spikerush, smartweed and cattails.

A total of three WCSs are in place to better manage water levels for this WMU. All of these structures are of the "flashboard" type, containing 24" diameter aluminum CMP. They are:

#04 - One 36' long pipe, with a riser height of 4', and an invert of 1.0' msl. Located in the A/B Crossdike, this structure is meant to drain B-Pool waters into A-Pool. This is the only structure intended to lower B-Pool water levels.

#06 - One 36' long pipe, with a riser height of 4', and an invert of 1.5' msl. Located in the East Dike, this structure drains the higher-elevation H-Pool into B-Pool. It can also serve to charge B-Pool when no other water is available.

#07 - One 42' long pipe, with a riser height of 5', and an invert of 1.0' msl. Located in the B/B-Storage Pool Dike, this WCS charges B-Pool with water from B-Storage Pool.

Two new GEMCO ditches were dug during August 1993, along the northern and eastern sides of B-Pool (Ref. Appendix B4, Map #10). These ditches parallel the East Dike and B/C Crossdike, and circulate water through an area that currently had very little circulation.

The eastern side of B-Pool contains a strip of Lilaeopsis carolinensis (Carolina lilaeopsis) adjacent to the East Dike, and within an old heavy equipment trail.

Recent migratory bird use of B-Pool is described in Section IVB.

3. WMU B-Storage (B-Storage Pool)

This is a relatively new impoundment that was completed in 1990 through partitioning off the westernmost side of B-Pool. That area has been converted into a water-storage facility that also transports water from C-Storage Pool to A- or B-Pool. It consists of approximately 13 acres of deep-water ditching and higher emergent wetland. Dikes surrounding this storage pool were built or raised to approximately 6.0' msl during 1990-1991, to provide a positive flow to adjacent pools.

Non-ditched elevations within this WMU average 1.5' msl. The southern end contains a small, four acre forest remnant of mixed hardwoods and softwoods, principally red maple, loblolly pine, a few pond pines, waxmyrtle and live oak. This habitat continues westward, outside the dike system, and into A-Pool, and is referred to as the "Green Hills" area of the Refuge. Emergent wetland plants also found in this pool include pondweeds, bladderwort, red-rooted nutsedge, smartweed, beggarticks, black needlerush and water primrose.

All three WCSs that serve this WMU include 24" diameter, aluminum CMPs and are of the "flashboard" type. Their descriptions follow:

#05 - Three pipes, each 48' long with a riser height of 6', and an invert of 1.0' msl. Located in the A/B Crossdike, the purpose of this WCS is to charge A-Pool, by flowing water from B-Storage Pool into A-Pool.

#07 - One 42' long pipe with an invert of 1.0' msl and a riser height of 5'. Located in the B/B-Storage Pool Dike, this WCS is meant to charge B-Pool, by flowing water from B-Storage Pool into B-Pool.

#11 - Three 48' long pipes with inverts of 1.0' msl and riser heights of 6'. Located in the B/C Cross-dike, this WCS is meant to charge B-Storage Pool, by flowing water from C-Storage Pool into B-Storage Pool.

4. WMU C-Storage (C-Storage Pool)

C-Storage Pool is a new impoundment that was completed in 1991, by partitioning off the southernmost 45 acres of C-Pool. It is located immediately north of B and B-Storage Pools. A 12,000 gallon per minute permanent pumping station is located adjacent to the pool on the west dike. A 1500' channel was dredged outside through a cove into Back Bay, in 1987, to feed water to the pump-station. The channel was approximately 20' wide and 6' deep and intended to provide water for the pumps to draw from, out of Back Bay. Periodic dredging of this channel is necessary about every three years, to keep it from filling with silt.

C-Storage Pool consists of deep-water ditching (15'-20' deep) that surrounds higher emergent wetland. A few waxmyrtles and live oaks exist on the higher areas, together with broomsedge, switchgrass and other Panicum species. More desirable wetland plants that are also present include: pondweeds, water primrose, red-rooted nutsedge, smartweed, beggarticks, and bladderwort. Some saltmeadow hay and black needlerush also are found in C-Storage Pool.

Dikes surrounding this WMU were raised to approximately 7.5' msl during 1990-1991, to accomodate the higher water volumes proposed. Non-ditched elevations within this WMU average 1.7' msl. All four WCSs that serve this unit are in place, and contain 24" diameter aluminum CMP. Their descriptions follow:

#08 - Two 36' long pipes, with riser heights of 5', and inverts of 2.5' msl. This "double structure" is located in the East Dike and meant to charge G-Pool, as well as H- and J-Pools, via WCSs #17 and #18.

#09 - One 48' long pipe, with a riser height of 6', and an invert of 1.5' msl. Located in the C/C-Storage Pool Cross-dike, this structure is intended to charge C-Pool by flowing water from C-Storage Pool into C-Pool.

#10 - This is a screwgate-type WCS, with two flap-gates at the ends of 32' long pipes. The inverts for these two pipes are 1.0' msl. This WCS is located in the West Dike next to the Pump Station, and drains C-Storage Pool into the bay.

#11 - Three 48' long pipes, with riser heights of 6', and inverts of 1.0'msl. This "triple structure" in the B/C Cross-dike, is meant to charge A-Pool, B-Storage Pool and B-Pool; by flowing water out from C-Storage Pool into B-Storage Pool, and then into A- and/or B-Pools.

This storage pool holds approximately 435 acre-feet of water, of which 139 acre-feet are not available for transport out of this pool, since that volume is below the 1.0'msl invert of the lowest WCSs here.

A GEMCO ditch along the East Dike connects the deep-water ditches along the B/C Crossdike and C/C-Storage Crossdike with WCS #08, in the East Dike (Ref. Appendix B4, Map #10). It was excavated in August, 1993. The intent is to provide better circulation in that higher elevation section of C-Storage Pool.

5. WMU C (C-Pool)

This WMU consists of approximately 190 acres of emergent marshes, open water, higher-elevation "islands" along the eastern side, and deep-water ditches. It is located immediately north of C-Storage Pool. Phragmites and needlerush are common, especially in the northern and western portions. Waxmyrtle, live oaks and grasses occupy the more northern and eastern areas. Other plant species present include Bacopa, smartweed, millets, panic grasses, saltmeadow hay, black needlerush, cattails and spikerushes. The best emergent wetland vegetation is in the center and southern portions of the impoundment. Habitats are similar to those of A- and B-Pools, except for a higher amount of waxmyrtle on the eastern side, and deeper water habitat on the southwestern side.

Non-ditched bottom elevations in this pool average 1.9'-2.0'. The highest ground is to the east, and the lowest in the mid-western part of C-Pool. A total of four WCSs are planned for this WMU. All are of the "stop-log" type, and possess one 24" diameter, aluminum CMP. Three are currently in place. Their descriptions follow:

#09 - One 48' long pipe, with a riser height of 6', and an invert of 1.5'msl. Located in the C/C-Storage Pool cross-dike, this WCS is intended to charge C-Pool, by flowing water from C-Storage Pool into C-Pool.

#12 - One 36' long pipe, with a riser height of 4', and an invert of 2.0'msl. Located in the East Dike, at the northeastern corner of C-Pool, this WCS is intended to drain the higher-elevation G-Pool into C-Pool. It can also be used to charge C-Pool.

#13 - One 36' long pipe, with a riser height of 4', and an invert of 2.0'msl. Located in the C/D-Pool cross-dike, this WCS can charge D-Pool, via the deep-water ditch that runs along the West Dike of C-Pool, by flowing waters into D-Pool from C-Pool.

#14 - One 36' long pipe, with a riser height of 4', and an invert of 1.0'msl. To be located in the West Dike, this WCS is meant to drain C-Pool into the bay. It is not yet in place.

A mile-long GEMCO ditch was dug along the eastern side of C-Pool during August 1993, to connect WCSs #09, #12 and #13, and improve the water circulation on that side (Ref. Appendix B4, Map #10). Several other east-to-west GEMCO ditches were also dug into C-Pool along its northeastern quarter then, to improve circulation, flooding and dewatering potential.

6. WMU D (D-Pool)

This 17 acre unit, also known as "the triangle", is located to the north of C-Pool. A small ditch located along the west side provides a limited amount of water to the area. Two WCSs are planned for this WMU. Both are of the "flashboard" type, and possess one 24" diameter aluminum CMP. One is currently in place. Their descriptions follow:

#13 - One 36' long pipe, with a riser height of 4', and an invert of 2.0'msl. Located in the C/D-Pool cross-dike, this WCS can charge D-Pool from C-Pool's deep-water ditch and also move water through D-Pool to E-Pool, if necessary.

#15 - One 36' long pipe, with a riser height of 4', and an invert of 2.0'msl. Located at the junction of the east and west D-Pool dikes (Ref. Appendix B1), this WCS is intended to charge E-Pool, by flowing water from the D-Pool ditch into the E-Pool ditch. It is not yet in place, but is scheduled for installation during early 1994.

WCS #13 was installed during December 1992. Until then, this unit had only two naturally wet areas. It principally supported upland grasses (switchgrass, etc.), young

waxmyrtles, and small patches of three-square and black needlerush. Despite past burning and disking, the vegetation composition remained principally upland, because of past limited flooding capabilities.

With WCS #13 in place, water levels are currently being managed at higher levels than previously possible. All wet areas of this pool were disced in late 1992, to eliminate much of the upland grasses present and smooth out the "ridges" supporting those grasses. The furrows and ridges were created by soil treatments several years earlier. The wet areas are still holding water after disking, and possess good moist soil management potential.

Bottom elevations of this pool average 4.4'msl. The highest ground (6.5'msl) is to the southeast; while the lowest (3.0'msl) is to the northwest.

This WMU needs further development, to include raising the existing dikes along the western side and northern end. Such improvements will allow higher water levels to be maintained.

GEMCO-ditching was carried out in this pool during August 1993 (Ref. Appendix B4, Map #10), to facilitate water transfer and increase the pool's moisture gradient.

8. WMU E (E-Pool)

This 25 acre unit is located to the northeast of WMU D and directly east of Refuge headquarters. This pool can presently only be flooded by rainfall, and/or a small "Gator" pump, that draws upon the waters of WMU D's western ditch. However, this ditch can be pumped dry in a short period of time and may not provide adequate water to rapidly flood E-Pool.

Bottom elevations in this pool average 3.0'msl in the open water area directly opposite the headquarters building; and 5.1'msl in the more southern and eastern areas. The eastern side runs up against the beach dune complex, where elevations are as high as 28'- 30'.

Two new WCSs serve this unit. The WCSs are of the "flashboard" type, with 24" diameter, aluminum CMP. Their descriptions follow:

#15 - One 36' long pipe, with a riser height of 4', and an invert of 2.0'msl. Located at the junction of the east and west D-Pool dikes (Ref. Appendix B1), this WCS is intended to charge E-Pool, from D-Pool, by means of the ditches there. It is not yet in place.

#16 - This structure is intended to replace the 8" screwgate WCS at the same location, once it is removed. It consists of one 24' long pipe, with a riser height of 4', and an invert of 1.0' msl. It is intended to drain E-Pool into the bay.

Recent management (1988 - 1992) has eliminated previously dominant waxmyrtle and black needlerush in the northern half, by disking during fall and winter, and flooding from fall to spring. The area now is dominated by upland grasses (southern half), three-square and diverse emergent wetlands plants. The best emergent marsh habitat exists in the northern half. The southern half was also disced during December 1992, to provide goose food and eliminate panic grasses. About 3 acres of solid waxmyrtle immediately south of the dune trail boardwalk, were hydroaxed in July 1992.

A GEMCO ditch was dug during August 1993, that encircled the pool along its periphery, to improve water circulation (Ref. Appendix B4, Map #10).

8. WMU F

WMU F is a 75 acre tract located immediately north of E-Pool, on the northern end of the barrier spit portion of the Refuge. It is bounded to the east and south by the Refuge entrance road; to the west by Back Bay and to the north by Little Island City Park. A borrow ditch (from entrance road construction) exists along the eastern edge. Several small ponds are scattered throughout this unit. These are "fed" by sheetflow from the bay when wind-influenced high tides exist, and by rainfall. The ditch seldom goes dry. Unit F habitats consist primarily of emergent marshes, and remnant dunes. Vegetation is predominantly black needlerush, with scattered patches of waxmyrtle. Some phragmites also exists.

No water control structures or pools exist in this unit; since water management does not seem practical for this narrow, small area, next to a paved road.

Most of this unit was drum-chopped in 1985 to discourage waxmyrtle. Dramatic vegetation changes, from waxmyrtle to black needlerush and three-square (Scirpus sp.), occurred during the following year.

9. WMU G (G-Pool)

This 88 acre unit is located to the east of WMU C and south of WMU E. It is bounded on the east by oceanfront dunes, to the west by the East Dike road. To the north, a small section of shallow dunes separates G-Pool from E-Pool. G-Pool has been dominated by upland grasses (Panicum sp.), waxmyrtle, bayberry, and live oak, with some three-square in wetter areas. During mid-June 1993 two eight acre blocks of dense waxmyrtle in eastern G-Pool were hydroaxed and later disced. The hydroaxing was done to increase biodiversity there, and reclaim additional wetlands. These two blocks will be managed for invertebrates and waterfowl foodplants in the future.

Unditched elevations in this pool average 3.7' msl; with the highest (5.6' msl and higher) elevations at the northern end, and the lowest (2.5' msl) at the southern end. The elevations also rise along the eastern side, where sand dunes rise to heights of 25'- 30' msl.

All three structures are 24" diameter aluminum CMP and 36' long. Their descriptions follow:

#08 - Two pipes, with riser heights of 5', and inverts of 2.5' msl. This "double structure" is located in the East Dike and meant to flow water from C-Storage Pool into G-Pool. It can also be used to charge C-Storage Pool from the ditch in G-Pool, if C-Storage Pool water levels are low enough (during the warmer seasons).

#12 - One pipe, with a riser height of 4', and an invert of 2.0' msl. Located in the East Dike, at the northwestern side of G-Pool, this WCS is intended to drain the higher-elevation G-Pool into C-Pool.

#17 - One pipe, with a riser height of 4', and an invert of 2.0' msl. Located in the G/H-Pool cross-dike, this WCS is meant to flow water from the higher elevation G-Pool, into H-Pool.

Water for G-Pool is principally derived from C-Storage Pool and rainfall.

Several GEMCO ditches were dug in this pool during August 1993, to better irrigate that drier end, and convert it to wetlands. The ditches run from WCS #12 north to the Dune Trail, and at right angles from the western deep ditch, into the borders of the two hydroaxed areas (Ref. Appendix B4, Map #10).

10. WMU H (H-Pool)

This 76 acre unit is located south of WMU G, east of the East Dike and WMU B, and north of WMU J. Unit H gets its water from G-Pool and rainfall.

Unditched elevations in this pool, average 2.8' msl, with several small, deeper ponds, averaging 1.7' msl. A high knoll exists in the northern half, that overlooks the northern "pond". It is 10.6'-11.0' high. The sand dune complex along the eastern side reaches heights of 20'-30'.

Three WCSs serve this WMU and are all in place. All structures consist of 24" diameter, aluminum CMP, that are 36' long. Further descriptions follow:

#06 - One 36' long pipe, with a riser height of 4', and an invert of 1.5' msl. Located in the East Dike, this WCS drains the higher-elevation H-Pool into B-Pool. It can also serve to charge B-Pool when no other water is available.

#17 - One pipe, with a riser height of 4', and an invert of 2.0' msl. Located in the G/H-Pool cross-dike at this pool's northern end, this WCS is meant to flow water from the higher elevation G-Pool, into H-Pool. It can be used to charge H-Pool.

#18 - One pipe with a riser height of 4', and an invert of 1.5' msl. Located in the H/J-Pool cross-dike at the southern end of H-Pool, this WCS is meant to drain water from the higher-elevation H-Pool, and charge J-Pool.

The vegetation composition of H-Pool is much the same as WMU G. It had been mostly upland (live oak, waxmyrtle and upland grasses), with two wetland areas predominated by three-square and millet (the largest millet stands on this refuge). During mid-June, 1992, a three acre block of waxmyrtle was hydroaxed along this unit's mid-eastern side. That block was subsequently disced, and flooded during the winter of 1992-1993. Moist soil management plans for that unit are geared towards converting it into emergent marshland, for spring and fall shorebird, and winter waterfowl uses. A small 3 - 5 acre patch of Phragmites exists in the hydroaxed area, that was treated with RODEO during 1992. The kill was only partial, however.

Four short GEMCO-ditches were dug during August 1993 that ran at a 90 degree angle from the deep, western ditch along the East Dike, eastward to the berm in front of the two hydroaxed

blocks (Ref. Appendix B4, Map #10). They were dug to provide better water flow into those cleared areas, and increase the moisture gradient there.

11. WMU J (J-Pool)

This 111 acre unit is located to the south of WMU H. It is bounded on the south by False Cape State Park, and to the west by WMU A. This unit has the most (33 acres) wooded swamp of any unit. Three-square and black needlerush dominate remaining wetlands, while live oak and waxmyrtle typify the uplands. J-Pool presently has the least wildlife-use potential, because so much of it maintains high elevations. It needs active management to convert its lower, drier upland-type habitats into more desirable wetlands and/or moist soil habitats.

Ground elevations generally grade upwards gradually, from the north to the south; with the highest average elevations (2.5'msl) to the south and east. Bottom elevations average 0.8'msl. The lowest elevation is 0.3'msl in the southwestern corner. Several knolls exist along the eastern side next to the sand dunes. They range in height from 4.4' to 7.8'msl. The sand dune complex ranges from 12' - 20' in height. The best emergent marsh potential is in the northern end, although further development is needed (ie. discing, burning and flooding).

Two WCSs are in place in this pool. Both are the usual "flashboard" type, with 36' long, 24" diameter aluminum CMP. Further descriptions follow:

#03 - One pipe, with a riser height of 4', and an invert of 1.0'msl. Located in the East Dike, near the southern end of J-Pool, this structure drains the higher-elevation J-Pool into A-Pool. It can also be used to charge A-Pool, during high water periods.

#18 - One pipe, with a riser height of 4' and an invert of 1.5'msl. Located in the H/J-Pool cross-dike, this WCS is meant to drain water from the higher-elevation H-Pool, and charge J-Pool.

12. WMU K (Long Island, Ragged Island and Western Islands)

This unit consists of approximately 2,400 acres, and includes the "marsh fingers" (west of B-Storage, C-Storage and C-Pools), Long Island, Ragged Island, and all of the remaining bay islands. No dikes or impoundments exist in this unit. Ground elevations average approximately 1.5'msl. During high

wind tides, most of the marshes in this WMU are overwashed by bay waters. Most of these island marshes have been so severely eroded during the last twenty years, that USGS Topographical Maps printed in 1971 no longer resemble the current shorelines.

Long Island contains approximately 800 acres. It includes a 35 acre agricultural field and two additional, unfarmed fields of about 10 acres each. The 35 acre field was planted to winter wheat in September, 1989 and October, 1990, and to ladino clover in 1991. These plantings are intended to serve as goose browse. The two 10 acre fields have remained fallow for over a decade and are reverting to brushy upland. Approximately 50 acres of hardwood (red maple) forest, with a few loblolly pines mixed in, also exist along the higher ground of the mid-eastern and northeastern areas. The remaining acreage to the west and south is emergent, black needlerush marshes, ponds, small guts and inlets. Long Island marshes have been burned about once every 6 years. Johnson grass was common in the old fields, but was controlled with a pesticide during 1989, and is presently sparse. Several large stands of Phragmites exist on the southern and eastern shorelines. Both are pest plants and have been treated with pesticides during the past five years.

WMU K also includes all the remaining bay islands. Ragged Island is the largest, with approximately 700 acres of emergent needlerush marshes, scattered waxmyrtle and open-water "potholes". Although Ragged Island may have once been a continuous unit, erosion has reduced it to a fragmented collection of islands and waterways. Along the southeastern side is an island with a higher piece of ground, and the ruins of an old home still evident.

The remaining 900 acres of bay islands and "marsh fingers" are exclusively emergent needlerush marshes, open water coves, waterways and "potholes", with several large stands of phragmites, waxmyrtle and three-square. These islands have been burned an average of once every five years.

14. WMU L - North Bay Unit

WMU L is the largest, and one of the three newest, units of Back Bay NWR. It includes newly acquired lands within the Refuge Acquisition Boundary. This WMU consists of all lands within that boundary from Muddy Creek and North Bay, eastward to the developed shoreline of the community of Sandbridge; and northward to the southern edge of Lake Tecumseh and Scopus Marsh. The western boundary is more difficult to define, but

includes sections of New Bridge Road and Asheville Bridge Creek; although in some areas acquisition lands have been earmarked on both sides of those landmarks.

The North Bay Unit includes Hell Point Creek, Black Gut, a series of large, connected marsh potholes, and lands on both sides of eastern Sandbridge Road (Ref. Appendix B1). Tract 104 was acquired in 1992; its 1,700 acres comprise most of this unit, along its eastern side. Those properties and an additional 520 adjacent acres, comprise 2,020 acres of this WMU that are now in Service ownership. This area has been designated by the State of Virginia's Division of Natural Heritage as the "North Bay Marshes Natural Area" and "Black Gut Natural Area", because of their intact and unique natural environments.

The proposed North Bay Natural Area is reported to house the rare plant Ludwigia alata (Winged seedbox). The proposed Black Gut Natural Area is reported to contain the following rare species: Plants - Fimbristylis caroliniana (Carolina fimbristylis), Ludwigia brevipes (Long Beach seedbox) and Eleocharis vivipara (Viviparous spikerush); Birds - king rail and least bittern; Insects - Enallagma durum (a damselfly), Poanes aaroni aaroni (Saffron skipper) and Epitheca costalis (Stripe-winged baskettail).

The newness of this WMU means that Refuge staff are not yet familiar with all the wildlife resources therein. As manageable units evolve, better descriptions will be provided. Most of the lands in this unit are wetlands with high waterfowl and shorebird use potential, including the pothole complex south of Sandbridge Road, and Black Gut, to its north. Predominant habitat types include bottomland woodlands (principally red maple, black gum and loblolly pine, with some cypress), upland agricultural and old fields, open-water potholes, narrow man-made ditches and canals, and emergent needlerush marshes with waxmyrtle and Phragmites stands.

The bottomland woodlands north of Sandbridge Road possess good forest management potential. Two or three small bald cypress stands exist adjacent to Black Gut, and could be expanded with additional plantings and/or control of competing deciduous species. Other desirable species such as white cedar, could also be planted and encouraged there, and red maple controlled and harvested.

Approximately 2,000 of the roughly 3,200 acres of WMU L have already been acquired as of 1993. No impoundments or functional water control structures are known to exist on this unit. Hell Point Creek is a man-made, straight, deep ditch

that runs from Asheville Bridge Creek to the mouth of Muddy Creek and western North Bay, and could provide management potential for additional pothole/pond creation.

15. WMU M - Beggar's Bridge Unit

WMU M is the second of the three new units within the newly approved Acquisition Boundary. It includes approximately 1,800 acres south of Muddy Creek, east of Muddy Creek Road, north of Beggar's Bridge Creek; and west of North Bay and Shipp's Bay (Ref. Appendix B1). This unit contains potentially high waterfowl use wetlands, including a series of shallow, connected potholes and Bridge Cove. Approximately 400 acres along both sides of Muddy and Asheville Creeks ("Muddy Creek Natural Area"), and 780 acres between Beggar's Bridge Creek and Porpoise Point - including Bridge Cove ("Porpoise Point Natural Area") - have been identified by the State of Virginia's Division of Natural Heritage as "Natural Areas", because of their unique and natural state.

The "Porpoise Point Natural Area" contains the following rare species: Plants - Lobelia elongata (Elongated lobelia) and Ludwigia alata (Winged seedbox); Birds - King rail. The proposed Muddy Creek Natural Area contains the following rare plants: Liliaeopsis attenuata (Carolina liliaeopsis) and Nothoscordum bivalve (Crow-poison).

The newness of this WMU means that Refuge staff are not yet familiar with all the wildlife resources therein. As manageable units evolve, better descriptions will be provided. Predominant habitat types include emergent needlerush marshes with associated waxmyrtle and Phragmites stands, open-water potholes, narrow ditches, narrow man-made ditches, agricultural and old fields, and some lowland woodlands (principally red maple and loblolly pine, with some bald cypress stands around Muddy Creek southern tributaries).

Approximately one-third of this WMU's 1,800 acres were acquired by late 1993. No impoundments or functional water control structures are known to exist.

16. WMU N - Nawney Unit

At approximately 1,400 acres, WMU N is the smallest of the new western units of Back Bay NWR. It includes newly acquired, or soon to be acquired lands, within the new Refuge Acquisition Boundary. This WMU consists of all lands within that boundary from Beggar's Bridge Creek to the north, Muddy Creek and Nanney's Creek Roads to the west, Shipp's Bay and Redhead/Back Bay to the east, and Mill Landing Road - Nawney Creek to the

south. It includes a block of wetlands and potholes that were part of the original acquisition for Back Bay NWR in 1938 (west of Great Cove and its associated islands, and including Landing Cove) (Ref. Appendix B1).

Nawney WMU contains less wetlands than the other two western units; however, those marshes are still high quality waterfowl and shorebird habitats. Most of Nawney Creek is included within this unit, together with Mose Island Point, Hill Landing and Drum Point. Predominant habitat types include emergent needlerush marshes with associated waxmyrtle and Phragmites stands, open-water potholes, bottomland woodlands (principally red maple and loblolly pine, with some bald cypress along the upper reaches of Nawney Creek), narrow ditches, and agricultural and old fields.

The State of Virginia's Division of Natural Heritage has identified 610 acres of wetlands on both sides of Nawney Creek, within this WMU, as a "Natural Area" ("Nawney Creek Natural Area"), because of its unique and natural state. The proposed Nawney Creek Natural Area is reported to house the rare plant Lilialeopsis attenuata (Carolina liliaeopsis).

Aproximately one third of this unit's 1,400 acres are in the process of being acquired, or have already been acquired during 1993. No impoundments or functional water control structures are known to exist on the Nawney Unit.

B. Recent Migratory Bird Use Trends

A-Pool:

This pool received more wintering waterfowl use during the winter of 1992-1993, than any other pool, largely because of management actions undertaken then (Ref. Section IV.C.1. of this Plan). A January, 1993 peak of approximately 3,000 snow geese, 350 tundra swans, 400 Canada geese, and large numbers of mallards and black ducks, and lesser numbers of pintails, widgeon, shovelers, blue-winged teal and coots used A-Pool.

Shorebirds (yellowlegs, dowitchers, killdeer, snipe) use the eastern, higher-elevation areas most, during the spring and fall migrations. Otters were consistently observed using the northern end's deep ditch during 1993, and crossing the East Dike into H and J-Pools.

B-Pool:

This pool received more early winter migratory bird use than any of the others during 1992. Mallards, black ducks, snow geese, widgeon, pintails, shovelers and blue-winged teal use this pool extensively during the winter. Coot and grebe use began increasing during the winter of 1992-1993.

Shorebird (Yellowlegs, snipe, dowitchers) use of the higher elevation eastern side is good during the fall migration, when water management practices provide habitat for them.

B-Storage Pool:

This WMU was used consistently by small numbers of blue-winged teal, cormorants, pied-billed grebes, ospreys and great blue herons during the fall and winter of late 1992-1993.

C-Storage Pool:

C-Storage Pool has been consistently used by a small numbers of Canada geese, tundra swans, mallards, black ducks, double-crested cormorants and pied-billed grebes during the past year or two. However, during the last two weeks of March, 1993, when the spring partial draw-down was in progress, this WMU was used by more ducks than ever seen there before. More than 125 birds (shovelers, green- and blue-winged teal, gadwalls, mallards, black ducks and a few widgeon) used the mid-pool area extensively. Good use of this pool's more open, center also occurred during November, 1993, when it was reflooded.

Ospreys regular fish in this pool's deeper waters. Shorebird use occurs in the eastern side of C-Storage Pool, during the spring and fall migrations. Yellowlegs, dowitchers, snipe and occasional small groups of dunlins and sanderlings are often present then. Otters were consistently observed using this pool during 1992 - 1993.

C-Pool:

Waterbird populations concentrate in the mid-pool area and the western side, where disturbances are minimal. Puddle ducks (mallards, black ducks and some Canada geese) generally prefer the interior, shallow areas, and the diving birds (coots, grebes, scaup, and ring-necked ducks) the deeper, western areas - although some mixing does occur. Waterfowl use is heaviest during the winter; although the spring and fall migrations bring good waterfowl use also, if pool levels are manipulated appropriately.

As with A- and B-Pools, the higher-elevation, eastern side of C-Pool is attractive to shorebirds (yellowlegs, dowitchers, and snipe) and smaller wading birds (tricolored, and little blue herons, glossy and white ibis, and snowy egrets) during draw-downs.

E-Pool:

The recent winter discings of 1988, 1989 & 1992, have provided previously unused winter feeding habitat for snow geese and ducks. Snow goose use peaked at 1,500 birds in January of 1992. The geese remained for several weeks during those three winters. Other migratory birds regularly using this pool include small numbers of mallards, black ducks, blue-winged teal, greater and lesser yellowlegs, snipe, long-billed dowitchers, great egrets, snowy egrets, great blue herons and glossy ibis.

WMU F:

This unit has been occasionally used in the past by snow geese and some ducks (principally mallards and black ducks) - the latter when weather-dependent water conditions are favorable. However, present use by migratory waterfowl is very limited to nonexistent.

G-Pool:

Migratory bird use in WMU G is presently limited to small numbers of mallards, black ducks, yellowlegs, osprey and egrets. However, with proper moist soil management techniques, such use should diversify and increase in the future.

H-Pool:

Frequent migratory bird use has been confined to small numbers of mallards, gadwalls, blue-winged teal and black ducks in the southern "pond", next to the dunes, and within the northern "pond" that also served as Compatibility Study site #11. Other migratory birds using this unit include the greater and lesser yellowlegs, great and snowy egrets, great blue heron and various neotropical songbirds. The shrubs/brush in the southern end of this WMU were used as staging areas by blackbirds during the fall of 1991 and 1992. Otters were regularly observed in the more southern end of this pool during 1993.

J-Pool:

Migratory bird use of this WMU is currently the lowest of any pool. Occasional use by a few yellowlegs, mallards, black ducks, and great egrets occurs during the spring. With further development, this pool should receive higher use. Low emergent marsh plant and invertebrate densities, and extremely sandy soils probably account for this low use rate by migratory birds. The shrubs/brush in this unit were used as staging areas for blackbirds during the fall of 1991 and 1992, particularly in the northern end. Otters were regularly observed using the deep ditch in this pool during 1993.

WMU K:

Waterfowl use of this unit concentrates most in potholes immediately west of the Long Island fields, and within Ragged Island. During the early 1990s, the Ragged Island area wintered several hundred Canada geese, 200 - 300 tundra swans, several hundred (each) mallards and black ducks, and less than 100 (each) green-winged teal, pintails, widgeon and gadwall. The Long Island potholes wintered less than 100 (each) mallards, black ducks, green-winged teal, pintails, widgeon and gadwalls. An additional peak of 5,000 snow geese have fed and roosted on the Long Island fields and adjacent water's edges during recent winters.

During the spring and fall migrations of the last few years, approximately 200 blue-winged teal, 500 green-winged teal, 500 Canada geese, 2,500 snow geese, 300 - 500 tundra swans, 500 black ducks and 300 mallards, have been found in WMU K.

WMU L:

Wildlife use of this WMU has not been documented, however, the presence of several duck-hunting blinds throughout this unit, and the ideal waterfowl habitat, attests to high waterfowl use. During the early morning of October 6, 1993, a flight of 15 rare fulvous whistling ducks was observed flying into the north end of Black Gut by the Refuge Biologist and Biological Technician.

Tract 127 has at least two ponds with associated wooded swamp which serve as staging areas for blue-winged teal, mallards, black ducks and wood ducks during migration; and as a wood duck breeding area during the spring and summer. Seven wood duck nestboxes were placed there during 1992.

Wading bird use has also been consistent in this WMU. Least and American bitterns have been observed on several occasions, together with great blue herons, egrets, grebes, coots and rails. An old bald eagle nest is located in this unit, that has had juvenile and adult eagles roosting near it during 1993. It could become active during 1994, and merits special consideration in future management decision-making in this WMU.

WMU M:

Wildlife use on WMU M has not been well documented, because of its newness. The southwestern section has supported a small breeding population of wood ducks, that have been encouraged by an active wood duck nestbox program. Tract 163, in the northern end of this unit, possesses good wood duck nesting potential. The presence of several duck-hunting blinds attests to high waterfowl use of this unit.

WMU N:

Wildlife use of this WMU has not been documented, although the presence of duck-hunting blinds therein bears witness to high waterfowl use. Law enforcement patrols of Nawney Creek in October, 1993, revealed a significant amount of adjacent emergent marshes and duck-hunting blinds, indicating a significant waterfowl population uses the area.

C. Historical Vegetation Response to Manipulation

The following information is provided as background historical information, for reference in future management considerations. The results of these actions were obtained through incidental observations, and not through a documented study. Maps are on file with the Refuge Wildlife Biologist, under "Soils/Land Treatments", that provide general details of these actions. The maps were provided by Back Bay NWR Maintenance Mechanic Ernest Maddron, who carried out most of the work referred to (Ref. Appendix B5).

1. Discing - 1986 & 1987

The Back Bay National Wildlife Refuge Annual Narrative Report - Calendar Year 1986 carries the following paragraph on page 14: "In late July and early August, Maintenance Mechanic Maddron discd,approximately 80 acres of rank, emergent vegetation (mostly black needlerush) in the lower areas (west and central) of C Pool. Results of this project were excellent, with lush emergent vegetation, and even some

SAV's (in the furrows) revegetating the area before the fall/winter waterfowl migrations. Significant duck use was noted this fall on the area."

"Upon the recommendations of Maddron, and ex-FWS employee Romie Waterfield, we tried discing rank black needlerush in A-Pool during late November and early December. In all, Maddron disced 25 acres with our LGP bulldozer. During and following the project, snow goose (peak of 3,000) usage on the disced area was noted by Refuge staff. Although we did not collect geese to determine what they were eating, we assumed that they were "munching" on needlerush roots."

During November, 1987 Refuge staff shallow-disced a two acre block of black needlerush in the northwestern corner of A-Pool as an experiment. The disced area was immediately flooded. Snow goose use of the area was heavy soon after. During the following growing season the disced site and all of A-Pool, were slowly drawn down until dry, by mid-June. The disced area produced a dense stand of saltmarsh bulrush during April and May. However, the dryness of the site during the summer produced an unknown upland plant with large, white-tufted seeds, that began invading and competing with the bulrush. During the following summer, the site was kept wetter, and the upland plant did not reappear, but the saltmarsh bulrush did. That block of saltmarsh bulrush still exists today, with little else occupying the same area.

2. Discing - 1992

Two 300' X 300' plots along the East Dike of A-Pool, and one along the A/B Crossdike, were shallow-disced during late April, 1992, to facilitate a Refuge Compatibility Study that was taking place there. The A/B Crossdike site was disced again during late July, 1992. Later observations during the summer and fall revealed good growths of Bacopa, smartweeds, Walter's millet, common threesquare, small spikerushes, sedges, Fimbristylis, beggar-ticks and rushes, in the two sites next to the East Dike. In addition, very small freshwater snails were common throughout these areas. The undisced, surrounding areas did not show this diversity. The A/B Crossdike site did not show as much diversity, and was predominantly Bacopa and mud.

These A-Pool areas were flooded during January 1993. The two East Dike sites were subsequently heavily used by widgeon, mallards, and pintails, and a few shovelers, black ducks, blue-winged teal and short-billed dowitchers. The A/B Crossdike site was used by lower numbers of mallards and black ducks, and higher numbers of coots and pied-billed grebes.

Two 300' X 300' blocks of marsh in B-Pool along the B/C Crossdike, one block along the East Dike, and two blocks along the A/B Crossdike, were shallow-disced during late April, 1992, to support the ongoing Refuge Compatibility Study. Yellowlegs responded well to discing, as did semipalmated and black-bellied plovers, and peeps. The two sites on the A/B Crossdike, and the westernmost site on the B/C Crossdike were disced again during late July, 1992, to remove tall grasses and needlerush that were obscuring survey visibility. The two sites disced only during April provided a diverse vegetative community similar to that in A-Pool, complete with snails. The three sites disced again during July provided low diversity, mud, and a notable snail absence.

When B-pool's water level was raised during August and September of 1992, duck use was heavy at the two sites that were disced only once during late April, and low at the other three sites. However, coot and pied-billed grebe use was moderate to heavy at the three sites that were disced twice.

A total of four 300' X 300' plots in C-Pool were also managed more intensively than the rest of the pool, during the Refuge Compatibility Study of 1992-93. The two plots along the northeastern side of C-Pool were disked once, after the growing season, in the fall of 1992. The other two plots along the C/C-Storage Pool Cross-dike were disked during April, and then again in late July, to remove vegetation that was obscuring waterfowl from observers' views. The sites that were disced twice drew limited duck (mallard and black duck) use, but good coot, gallinule and pied-billed grebe use. The sites disced once, drew good mallard and black duck, and limited canada goose, use.

3. Phragmites Control & Burning

The exotic Phragmites has been recognized by the Fish & Wildlife Service as a pest plant that dominates and degrades wetland habitats. Refuge staff have been actively controlling dense stands of this reed since 1987, through use of the approved pesticide RODEO. Large dead stands of Phragmites have been removed by burning, to provide for more desirable emergent foodplants. Burned sites have been reviewed for burn effectiveness and new plant presences as part of the burn evaluation process. In nearly all cases desirable waterfowl food and cover plants have reclaimed the ground once occupied by the Phragmites, after the dead plants were removed by burning. Beneficial plants such as smartweeds, dock, Bacopa, sedges, beggar-ticks, three-squares, millets, spikerushes and black needlerush are some examples of the diversity that have replaced Phragmites, following its removal at this station.

Phragmites has been controlled by RODEO applications and burning in the following WMUs: C-Pool, D-Pool and WMU K's Long Island, "marsh fingers", Western Islands and Ragged Island areas. Such control efforts must continue as ongoing programs in the years ahead, in view of the current Phragmites presences throughout the existing Refuge, and within new acquisition lands. The Refuge entered into a cooperative agreement with the State Division of Natural Heritage during 1993, to evaluate the long-term effectiveness of Phragmites control.

Controlled burning has also been consistently used during the last six years, to provide snow goose access to needlerush rootstocks, by removing the sharp needlerush stems.

Even when green, black needlerush will carry a good, hot flame. Following fall and winter burning, snow goose use of burned needlerush sites has skyrocketed. Burning alone does not appear to significantly retard black needlerush density from one year to the next; however, the combination of burning and goose feeding does thin out needlerush densities, and may also diversify the monotypic needlerush stand. Burning of needlerush is also only possible on a three year rotation, since not enough duff exists to carry a flame when more frequent burning is attempted.

4. Drum-Chopping

During October and November of 1984, 47 acres of waxmyrtles, willows and red maples were drum-chopped with a caterpillar D7-E pulling a drum-chopper rented from the Virginia Division of Forestry. The drum-chopped area was subsequently root-raked. The treated area was in WMU F, next to the Entrance Road. These 47 acres were reported to have developed good stands of three-square bulrush during the two years after drum-chopping. However, in the absence of further treatments, the site experienced significant waxmyrtle regrowth, that has presently reclaimed much of the site.

5. Root Raking

The Annual Narrative Report for Calendar Year 1986 (pages 13 and 14) reports the following: "During February and March, Maintenance Mechanic Maddron root raked 62 acres of vegetation in thenorth mile (adjacent to the Entrance Road) and in (northern) C-Pool. Although the initial results were encouraging (with good emergent marsh vegetation replacing the woody growth), a few months after (the) C-Pool draw down, the

marsh vegetation began to be replaced by upland grasses. By the end of the summer only the west sides of the raked areas remained in emergent marsh types."

Apparently there was a total draw-down during the early summer that completely dried the ground and allowed upland types of grasses to become established. The soil should have been maintained in a moist soil state, with saturated soils (1"- 2" water) present throughout the early growing season, followed by a gradual drawdown. This would have preserved the marsh emergents and excluded most of the upland grasses.

Root-raking was also performed in G, H and J-Pools under the power line right-of-way during late 1989 and early 1990 (Ref. Appendix B3, Map #6).

D. Biological Concepts

1. General Concepts

The following ideas apply generally to water level manipulations within the impoundment system at Back Bay NWR:

a. Waxmyrtle stands constitute "thermal cover" for migratory birds during cold and windy periods. Further removals should be carefully examined, to insure that such reductions do not negatively impact waterfowl and shorebird use of the impoundments and their immediate vicinities.

b. Live oaks not only constitute additional "thermal cover", but their acorns also provide a mammalian and migratory bird winter food resource in this area. Removal of live oaks is discouraged.

c. All planned water management draw-downs are to be conducted slowly, at a rate of 2"-3" per week, and no faster. Further discussion in Section e. below details why.

d. Winter water management goals for shorebirds and waterfowl may conflict; since shorebirds require drawn-down wetlands during the fall and winter, while waterfowl require flooded wetlands.

e. Both waterfowl and shorebird water management practices should be aimed at providing ideal moist soil habitats for invertebrates and waterfowl food-plants. In the past, the invertebrate populations of each WMU have not been taken into consideration. Rapid drawdowns (water drops of >3" per week) negatively impact both invertebrate and waterfowl food-plant production. Allowing significant acreages within each WMU to

dry out completely will eliminate most desirable invertebrates and waterfowl food-plants and replace them with undesirable panic-grasses, broom-sedge, fennel and forbs.

f. The shorebird foraging guilds using the Refuge most will dictate what water depths, vegetation density and forage bases are desirable, for the Annual Water Management Program. Fall migrants and summer residents common to the Refuge pool complex include the greater and lesser yellowlegs, short- and long-billed dowitchers, and snipe (all of the "probers" guild). Spring migrants include small flocks of the least sandpiper, black-bellied plover, whimbrel and killdeer (of the "pickers" and "probers" guilds). "Probers" can tolerate some standing water (1"- 2") depths; while "pickers" prefer exposed ground, without standing water. Appendix A5 provides a list of the different shorebird foraging guilds by species (from Helmers, 1992, p.5).

g. This Plan may only be valid for 5-10 years, before requiring revision. It is vital to the success of the Marsh and Water Management Plan and Program, that annual evaluations of management practices be carried out. These evaluations should measure responses of invertebrates, waterfowl food-plants (from vegetation transects), waterfowl use and shorebird use, to water management practices, and be included in the Annual Marsh and Water Management Program for the following year. This new knowledge should result in revisions to this Marsh & Water Management Plan 5-10 years after its approval.

h. A slow, partial drawdown for spring waterfowl migrants is recommended for future water management practices. This partial draw-down should bring water levels down about half-way between the peak "high-water" levels of January and February, and the peak "low-water" levels of June and July. It is recommended that this partial drawdown commence during mid-March and be completed by mid-April. The intent behind this draw-down is to make invertebrates, seeds and other foods that were previously out of reach because of deeper water, available to spring waterfowl migrants. This practice resulted in increased shoveler, blue-winged teal, gadwall, green-winged teal, mallard and black duck use during April 1993.

i. The shorebird migration in this area peaks during May. Therefore, those WMUs being managed for shorebird habitat, should be slowly drawn-down during late April and early May, to provide the maximum acreage with a depth of 0"-2" of water. This will primarily take in the eastern sides of A-, B-and C-

Pools, and much of E-, G-, H- and J-Pools. The slow draw-down will provide good edge/water interfaces, as forage areas for early April shorebird arrivals.

j. Waterfowl and shorebird numbers drop significantly during June - August. During this same period, waterfowl food-plant production and invertebrate productions should be on the increase. Such production can be maximized if the water level of a pool is slowly drawn-down (especially during periods of high temperatures) to the lowest possible point, while also maximizing the acreage within a pool that is still saturated with water. It is critical to good moist soil management that the water saturation state still be maintained as much as possible, during this "growing season", even in the absence of standing water. Drying out of significant acreages within managed pools must be avoided.

k. To prepare for the fall shorebird migration, as much acreage as possible in shorebird-managed pools should receive a covering of 0"-2" of water, during early August. Fall flooding should coincide with the arrival times and population size of fall migrants. This will also benefit early arriving waterfowl, such as teal. Complete submergence of some desirable moist soil plants for longer than 2-3 days can retard their growth and seed production (ie. millets, smartweeds, etc.). Complete submergence of seedlings/sprouts for several days during April and May can eliminate them.

l. Pool levels need to be raised in increments of no more than 2"-3" per week, during the winter; as duck use diminishes within a WMU. This will necessitate the raising of water levels two or three more times during the winter (November - February), after the initial water level increases of late October - early November. As levels are increased, additional food is made more available to wintering waterfowl. If duck use does not diminish, the WMU's water level should remain the same. A reasonable rule of thumb is to have 85% of the surface area of a WMU/pool flooded to an optimum foraging depth at the peak of the fall waterfowl migration (Fredrickson, 1991, p.7).

m. Periodic water level fluctuations are necessary to:

- (1) Control undesirable emergent vegetation around the perimeter of the impoundments;
- (2) Consolidate suspended organic matter into the soil.
- (3) Maximize availability of migratory bird foods present.
- (4) Provide water to other WMUs.

n. Appendix A5 contains a listing of habitat conditions that attract vertebrates (birds, amphibians, mammals and reptiles) to moist soil impoundments.

2. Waterfowl Moist Soil Management Techniques.

At Back Bay Refuge, fall waterfowl populations begin building up during October. The most common fall migrants include the mallard, black duck, green-winged and blue-winged teal, pintail, widgeon, snow and canada goose, and tundra swan. Snow geese arrive during November in large numbers (5,000-10,000 during 1991-1993), as do several hundred tundra swans and canada geese. Other less common fall waterfowl species include the gadwall, wood duck, shoveler, hooded, red-breasted and American mergansers, and ruddy duck. Peak fall waterfowl numbers reached approximately 1,700 ducks, 500 geese and 100 coots during October of 1992; and 1,500 ducks, 3,600 geese, 425 coots and 75 swans in November, 1992.

The annual peak waterfowl population usually occurs during December through January, making Back Bay NWR's highest priority at that time of year, providing for the needs of wintering waterfowl. January, 1993 waterfowl peak populations were approximately: 800 mallards, 500 black ducks, 175 shovelers, 175 pintails, 100 widgeon, 50 blue-winged teal, 25 gadwalls, 500 coots, 200 tundra swans, 3,100 snow geese, 375 canada geese, and less than 10 per species for hooded, American and red-breasted mergansers; most of which used the pool complex. Higher numbers of some species have been noted in prior years.

The most common waterfowl species present during the spring within Back Bay Refuge's WMUs are the shoveler, mallard, blue-winged teal, wood and black ducks. Only a few (25 or less) snow geese, canada geese, tundra swans, gadwalls, pintails and widgeons are normally present then. Common diving birds include the coot and pied-billed grebe. Peak duck and goose numbers may reach 800. Waterfowl use during the spring of 1993 was heaviest within the previously disced needlerush stands on the western side of A-Pool, and the Compatibility Study sites along the eastern side. Both areas had been disced during 1992.

Summer waterfowl populations drop to the annual low of about 200 birds for all species, with mallards making up the bulk. Other waterfowl species present then include the black duck, blue-winged teal, wood duck and Canada goose. Summer populations are highest in areas holding water, such as western and central C-Pool, B-Storage and C-Storage Pools, and the bayshores.

Marsh and water managers must recognize the relation among habitat structure, water depth and water use by waterfowl. Table #1 below emphasizes this point.

TABLE #1 - Water Depths and Vegetative Characteristics at Foraging Sites of Some North American Waterfowl (from Fredrickson & Reid, 1988).

<u>Species</u>	<u>Water Depth</u>	<u>Vegetative Structure</u>
Large Canada geese	dry, mudflat <10 inches	short herbaceous, rank seed-producing annuals
Northern pintail	<10 inches	open water with short, sparse vegetation
Mallard	<10 inches	small openings, tolerate robust vegetation
Ring-necked duck	>10 inches	scattered, robust emergents
Lesser scaup	>10 inches	open water, scattered submergents

The mallard, wood duck and blue-winged teal readily use habitat with dense vegetation; while the northern pintail prefers shallow, open habitats where visibility is good and vegetation is sparse.

Refuge waterfowl management efforts should focus on the following basic water management principles:

- a. Early spring to mid-spring drawdowns provide food resources for late migrants such as shovelers and teals.
- b. Appropriate water depths need to be available for effective waterfowl management. Shallow water is essential for dabbling ducks, since the optimum foraging depth is 2"-10" (Fredrickson & Reid, 1988).
- c. Gradual drawdowns lasting into mid-summer, are needed to establish moist-soil vegetation. This vegetation is frequently valuable waterfowl food.

- d. Gradual reflooding in late summer to early fall optimizes use of the new seed, moist soil plant, and invertebrate (insect larvae and adults, snails, amphipods, etc.) food resources by waterfowl.

Long-term moist soil management practices should not follow the same schedule from year-to-year. Fredrickson (1991, p.4) cautions against "repetitive manipulations scheduled for specific calendar dates, year after year", since they are often associated with declining productivity of the wetland. The potential for interchanging pool objectives from waterfowl to shorebirds, from one year to the next, is therefore great; since doing so would eliminate "repetitive manipulations". Figure #5 represents a hypothetical moist soil flooding regime for a three or four year water management cycle, that diversifies the annual water management program for waterfowl and shorebirds.

Recommended waterfowl management at Back Bay Refuge should provide for a slow, spring to early summer drawdown for most pools, to allow annual waterfowl food-plants to germinate and grow on exposed, moist mud/sand flats. Some water (about 2"-3") should be returned during August, after good growths of the food-plants have developed. Flood the pool during winter to higher levels, especially in those areas affected by summer drought (as in 1993) or hard, winter freeze, to restore and protect larval invertebrate populations. This scenario is similar to shorebird management recommendations espoused by Eldridge (1990 & 1992), Helmers & Castro (1990), and Helmers (1992). In fact, much of the discussion in the following shorebird management section may also be applied to waterfowl.

3. Shorebird Moist Soil Management Techniques

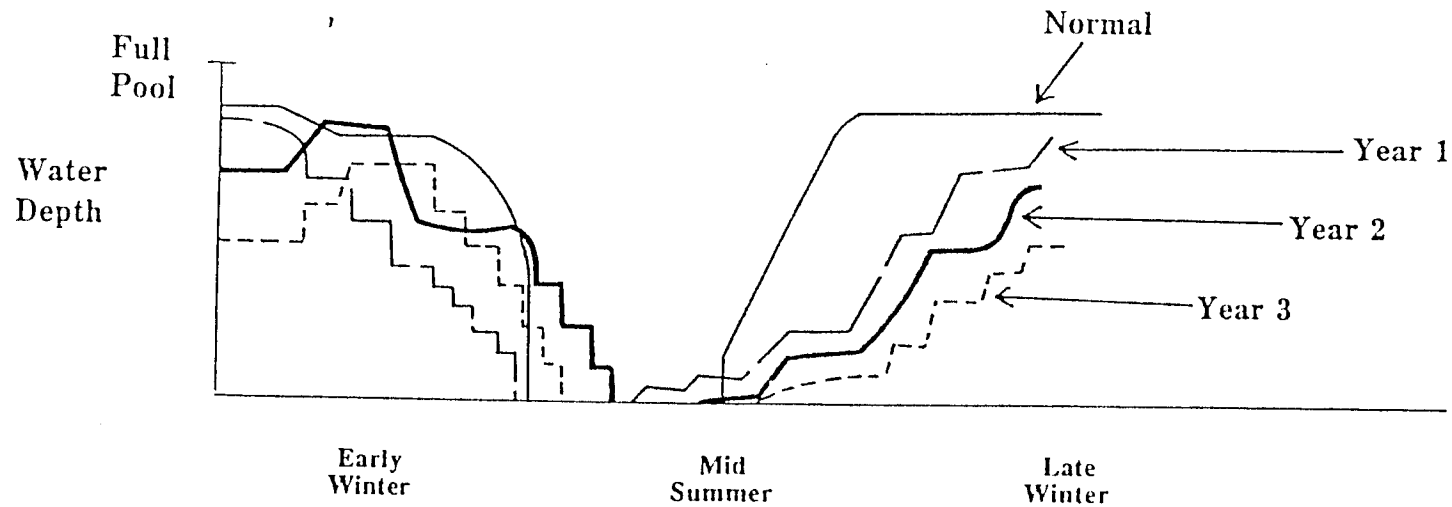
Shorebird species using Refuge WMUs during the spring and fall, consist of the following: greater and lesser yellowlegs, short-and long-billed dowitchers, snipe, killdeer, and occasional dunlins, semipalmated plovers and sanderlings. Currently, with shorebird management just getting started, the numbers using refuge impoundments total about 150-200 birds during the late summer/fall annual peak. Spring numbers have been lower than the fall in the past; however, this may have been due to past practices of maintaining the WMUs at higher levels than shorebirds prefer, during the spring migration in late April through May. Spring and fall shorebird use is expected to rise, once the shorebird management recommendations herein are instituted. Shorebird nesting at Back Bay Refuge is not known to occur. Use by these species also occurs throughout marshes in the rest of the Refuge, and the beach, where their numbers are higher.

During migration, shorebirds look for the right combination of habitat characteristics. Eldridge (1992) lists these characteristics as:

- a. A wetland in partial drawdown.
- b. Invertebrate abundance of at least 100 individuals per square meter.
- c. A combination of open mudflat and shallow water (3-5 cm./1-2 in.) in a wetland basin with gradually sloping sides.
- d. Very little vegetation.

The most important of these characteristics are the invertebrates; without them, the shorebirds will not stay. Therefore, encouraging invertebrate production and then making those invertebrates available to the birds is critical to effective shorebird management. When water levels are drawn down slowly (1"-2" per week) during the right times of year, shorebirds are attracted to the available invertebrates. A slow, continuous drawdown provides the birds with new habitat and invertebrates (Eldridge, 1990 & 1992), Helmers (1992).

The critical nature of drawdown rates is illustrated in Table #2 (Fredrickson, 1991). Fredrickson (1991, pp.5-6) further states, "Slow drawdowns (2-3 weeks) usually are more desirable for plant establishment and wildlife use.....Slow drawdowns lengthen the period for optimum foraging and put a large portion of the invertebrates within the foraging ranges of many species.Slow drawdowns are always recommended to enhance the duration and diversity of bird use."



Rationale

Normal - Typical midsummer drawdown to establish moist-soil vegetation. Fall and winter flooding for waterfowl.

Year 1 - Gradual drawdown to optimize use by late spring migrants. Gradual reflooding for rails and waders.

Year 2 - Gradual drawdown lasting into midsummer to optimize use by late spring, migrant waterfowl, shorebirds, and waders. Gradual reflooding in fall to optimize use of seed resources.

Year 3 - Increasing water depths in spring to make food resources available. Gradual drawdown by late spring, followed by gradual reflooding in fall to shallow depths.

Figure 5. Suggested flooding regimes for seasonally flooded wetlands of the Midwest.

TABLE #2 - Comparison of Plant, Invertebrate, Bird, and Abiotic Responses to Rate and Date of Drawdown Among Wet and Dry Years (from Fredrickson, 1991, p.5)

	Drawdown Rate	
	Fast*	Slow**
PLANTS		
Germination:		
Period of ideal conditions	Short	Long
Root development:		
Wet year	Good	Excellent
Dry year	Poor	Excellent
Seed production:		
Early season	Good	Excellent
Mid-late season	Not Recommended	Excellent
Wet year	Good	Good
Dry/Drought year	Poor	Good
Cocklebur production	Great Potential	Reduced
INVERTEBRATES		
Availability:		
Early season	Good	Excellent
Mid-late season	Poor	Good
Period of Availability	Short	Long
BIRD USE		
Early season	Good	Excellent
Mid-late season	Poor	Good
NUTRIENT EXPORT		
	High	Low
REDUCING SOIL SALINITIES		
	Good	Poor
*Less than 4 days **Greater than 2 weeks		

In our area, drawdowns should coincide with the spring shorebird migration (May); commencing during mid-April, and continuing through May. Pools should also be drawn down asynchronously, so that some shorebird habitat is available during both spring and fall. If more than one unit is being drawn down for shorebirds, water manipulations should be staggered, to extend the availability of habitat (Helmers, 1992). In late summer, drawdowns can be scheduled from July to October, if possible, to provide for the fall shorebird migration.

Shorebirds feed most on Chironomidae (Midge fly) larvae; although they may also take what is most abundant in a wetland during a drawdown. They probably select the largest and easiest to catch aquatic insect larval form, including numerous beetle, mayfly, biting fly, dragonfly, damselfly and dobsonfly larvae. However, several studies have revealed that midge larvae are usually the most abundant invertebrate in U.S. wetlands. The larvae grow from 2mm to as large as 24mm. A high midge biomass should be the primary goal of shorebird management. The most important midge larvae for migrating shorebirds are the Chironominae species known as bloodworms. They are most abundant in shallow, open water, unshaded by submergent and emergent vegetation, that promotes the algal growths they feed on.

Management specifically for shorebirds during the spring, should provide areas where large bloodworms have overwintered, and are exposed in the shallows of gradually receding wetlands. Because many waterfowl hens and broods also consume midge larvae, such habitat management is also beneficial for waterfowl. Early colonizing midges, such as Chironomus tentans, flourish in wetlands maintained in an early successional stage typical of most moist-soil-management-units (Helmets, 1992). Management for late summer/fall shorebird migrants, should consist of holding two pools higher during the spring and summer, and delaying the drawdown until the peak of the southbound migration arrives in August.

To evaluate and determine whether midge larvae and shorebirds are responding to the water management as expected, shorebird censuses and midge sampling in wetland sediment need to be carried out. Shorebirds counts are conducted on a weekly basis and can focus on treated shorebird areas separately. Core samples can easily be taken with a simple core sampler (such as a graduated cylinder with a diameter of approximately 7-10cm.), to a depth of 3cm. into the mud, and then wash the sample through a screen. The number of midge larvae per square meter of mud flat can be extrapolated from the sample count of larvae in the core sample. A count of at least 100 midge larvae per square meter is necessary to attract and hold shorebirds (Ibid, 1992).

A number of water management options are available for use at Back Bay Refuge. Table #3, below, illustrates these options, together with expected shorebird use (modified, from Helmers, 1992, Table 2.4, p.23).

TABLE #3 - Drawdown & Flooding Manipulation Options & Shorebird Use During Migration

<u>Manipulation</u>	<u>Time</u>	<u>Shorebird Use</u>
Spring early drawdown	February - April	Moderate
Spring late drawdown	May - June	High
Maintained spring flooding	Through Spring	Low
Spring partial early drawdown	February - April	Moderate
Spring partial late drawdown	May - June	Moderate
Fall early flooding	July - August	Moderate
Fall late flooding	September - October	Low
Maintained fall flooding	Through Fall	Low
Fall early drawdown	July - August	High

Recommended shorebird management at Back Bay NWR should provide for a slow spring drawdown in most pools, to expose invertebrates for foraging. Water should be returned during August, after substantial waterfowl foodplant biomass has developed; but, water depths should be kept shallow (0-3"). Flood the pools during the winter to higher levels, especially in those areas affected by a summer drought or hard, winter freeze, to restore and protect larval midge populations. Eldridge (1990 & 1992), Helmers & Castro (1990), and Helmers (1992) espouse this scenario for shorebird management. This strategy should also benefit waterfowl populations.

To provide for late summer/fall shorebird migrants, disk the moist soil unit during the late summer (late July - August), and flood shallowly, so that the pool contains a good interspersed mudflat, shallow water, and deeper water - to provide additional habitat as the wetland dries (Eldridge, 1990 & 1992). Insure that units are flooded by the fall migration.

The key to success lies in adhering to the following:

- a. Keep upland vegetation in and around the pools mowed or disced (Eldridge, 1992).
- b. Time the drawdowns/floodings to coincide with the local migration.
- c. Conduct all water manipulations slowly, so invertebrates can adjust to the changes.

Fredrickson (1991, p.4) further states, "Repetitive manipulations scheduled for specific calendar dates year after year are often associated with declining productivity. Management assuring good production over many years requires variability in drawdown and flooding dates among years." Therefore the Annual Water Management Program needs to maintain variable drawdown dates for different pools, from year to year; and occasionally interchange objectives, so that the same area of a pool is managed for shorebirds during one year, and for waterfowl the next. It is recommended that G, H and J-Pools be primarily managed for shorebirds, together with the easternmost sections of A- and C-pools.

4. Combined Waterfowl/Shorebird Moist Soil Management Techniques

At the risk of being redundant, most spring, summer and fall waterfowl and shorebird moist soil management practices are not mutually exclusive. That is, what is good for waterfowl at those times of year, should also be good for shorebirds. The information presented in the above Sections 1, 2 and 3 should suffice, where recommended management practices during the spring, summer and fall are concerned, for either bird group.

The principle conflict between management for these two migratory bird groups arises during the winter. Shorebird management guidelines (Eldridge, 1992 & Helmers, 1992) often call for a winter drawdown. Such a drawdown conflicts with waterfowl management guidelines that call for winter flooding, and may also negatively impact invertebrate populations. Depletion of this food resource will probably occur, to the point where less is available for the spring waterfowl and shorebird migrations. Winter shorebird use of the water management units is very low, while waterfowl use is relatively high.

Therefore, unless a specific need arises to manage a pool for wintering shorebird populations, winter drawdowns should not be utilized.

5. Undesirable Species and Need for Control.

The desirability or undesirability of specific plant or animal species within a WMU shall be determined based upon its value as a waterfowl and/or shorebird food, and whether it is common or not throughout nonimpounded areas of the Refuge. Those species that are of limited food value and which are relatively common throughout other Refuge areas or adjacent

lands/waters will be considered undesirable, and subject to control efforts. Control efforts may consist of mowing, discing, plowing, flooding, burning, treating with the pesticide RODEO, or a combination thereof.

A tremendous amount of funding and manpower have gone into the construction and upgrading of the WMU complex. Therefore, their interiors should consist of high-quality waterfowl and shorebird habitats that justify the expenditure. Black needlerush, upland panic-grasses (Panicum sp.) with little food value, Phragmites communis, and other non-native species, are some examples of undesirables within Refuge pools. Active control efforts were undertaken during 1992-1993 to reduce the amount of needlerush acreage within A and B-Pools, by discing and flooding, and encourage the germination of other more diverse emergent and submergent waterfowl food-plants.

6. WMU Habitats - Desired Characteristics & Goals.

Refuge impoundments should provide habitats that cannot be provided by the outside bay's natural marshes. This may necessitate the control of some species that are common within outside bay habitats (ie. black needlerush, etc.). Habitats within each Refuge WMU should be as ideal as possible, for waterfowl and/or shorebird use. Such habitats should consist of open, relatively exposed, level emergent marshes, with wet/saturated soils and diverse waterfowl foodplants and invertebrates. Stands of black needlerush, upland panic-grasses, Phragmites and broom-sedge (Andropogon sp.) must be controlled and eliminated; since the space that they occupy should be producing high-quality food-plants and invertebrates instead. Upland panic-grasses and broom-sedge are usually controlled through good moist-soil management practices that include flooding.

Existing bottom elevations/contours must be maintained in their existing west to east gradual down-slope, to provide for the gradual drawdown and flooding scenarios that optimize the best food availability for shorebirds and waterfowl. The GEMCO ditch system should be cleaned out every five years in all pools, to continue providing water circulation, increased moisture gradients in drier areas, and additional wading bird forage sites during draw-downs.

The northern areas of A, B and C-Pools, and eastern G, H & J-Pools, should maintain the existing shrub and tree stands for cover-loving ducks and thermal cover during the cold season. Shrubs and trees need to be viewed in relation to their food and thermal cover values for migratory birds, and not be destroyed unless absolutely necessary.

During the peak waterfowl population periods of December, January and February, each pool being managed for waterfowl should have approximately 85% of its surface area covered by shallow water.

During late February and March, a partial drawdown should take place to provide shallow water for the spring waterfowl migration. Further drawdowns during April will provide exposed soils and new wet edge areas for shorebird foraging during their migration in late April and May.

Germination needs to be encouraged by continuing the drawdown until as much soil surface as possible is exposed. Avoid allowing the sandy soils to completely dry out for longer than a week. With very little surface water available at that time of year, groundwater levels can be monitored via levels in the GEMCO ditches in each pool. During the driest time of year (usually June or July), each pool should maintain several inches of water in the GEMCO ditches, to avoid stressing moist soil plants and invertebrates.

E. Unit Management Capabilities

Appendix B2 details the intended water flow directions and scheme for each WCS, for all WMU/pools. Appendix C provides information on bottom elevations and surface area/capacity curves for WMUs A, B and C. In addition, topographic maps provided by our Engineering Division at the Regional Office, are available, that also detail bottom elevations for those three pools.

Although the below WMU/pool descriptions detail the intended use of the many WCS interconnecting the different WMU, it should be understood that under certain conditions, "reverse" water flows can be achieved. Such "reverse flows" may allow pools to be drained or flooded differently than originally intended.

Such was the case during the spring of 1993, when WCSs #04 and #14 had not yet been constructed. Drawing down B and C-Pools was necessary, but not possible as planned; i.e. by dumping C-Pool waters into the bay and B-Pool waters into A-Pool, and thereafter into the bay. However, by drawing down B and C-Storage Pools, water could be dumped into them (from B and C-Pools), and from C-Storage Pool into the bay, through WCS #10 (twin screwgates) - the reverse of what the original water flow scheme shown on the map in Appendix B1 details. C-Pool was then slowly drawn down in time for the spring waterfowl migration. Therefore, during emergency situations, other options for reaching objective water levels should be examined and implemented, if necessary.

The water source for the pool complex originates from the freshwater bay to the west. A large 12,000 gallon per minute pump station located on the corner of the southwestern dike, moves water from the bay into C-Storage Pool. From C-Storage Pool, water can be transported through a series of WCSSs to any WMU, to meet WMU objectives. Precipitation also contributes significantly to meeting water management objectives for all WMUs, especially during the fall when water levels are being raised.

A, B and C-Pools are subdivided into eastern (higher-elevation) and western (lower-elevation) subunits, as shown in Appendix B1 and explained below. Subdividing aids in identifying the shallower and deeper water areas of each pool during flooding, drawdown or other management operations. A-1 Pool (the shallower eastern area) may then be principally a shorebird management unit, while A-2 Pool (the deeper western area) simultaneously becomes a waterfowl management unit, should the need arise to manage the same pool for both bird groups.

In general, subunits A-1, B-1 and C-1 provide good shorebird and waterfowl use potential; while subunits A-2, B-2 and C-2 provide the best waterfowl management potential. Once the highest-elevation G, H and J-Pools are improved upon (to remove undesirable species), and water levels are managed better, they will provide excellent shorebird habitat.

General WMU/Pool objectives are provided below.

1. WMU A (A-Pool)

This WMU currently seems to have the best moist soil management potential, since it is large and relatively level, with a shallower, higher elevation, eastern side and a gradually sloping, lower elevation, western side. That elevation difference is used to roughly subdivide it along a 1.50' msl bottom elevation, into two subunits: A-1 on the east, and A-2 on the west. Such a dividing line follows a north to south slightly diagonal line, along the length of this pool (Ref. Appendix B1, Map A). Subunit A-1 (~80 acres) can be managed for both migrating shorebirds, and migrating and wintering waterfowl; while Subunit A-2 (~115 acres) may be managed for waterfowl, year-round.

Thermo-regulatory habitat ("windbreaks") within A-Pool is limited to approximately 20 acres of forested wetlands along the western edge and approximately 15 acres of tree and shrub covered "islands" within the central part of Subunit A-1. In addition, the East Dike also serves as a windbreak during the winter, when the prevailing winds are from the northeast.

WMU A receives water from C-Storage Pool, via B-Storage Pool to the north. The triple-tubed WCS #05, located in the A/B crossdike, controls the water flow from B-Storage Pool. The three tubes allow a large volume of water to be flooded into A-Pool, when B-Storage and C-Storage Pools are high enough. The twin screwgated tubes at WCS #01, in the southwestern corner of A-Pool, allow for rapid drainage (or filling, when bay waters are high enough, and pool levels low). Water control structure #02 and adjacent ditches provide water to False Cape State Park, while also providing additional A-Pool drawdown capabilities.

Management objectives for WMU A are to produce approximately 25 acres of mixed fine-seeded (spikerushes, small rushes, etc.) waterfowl food-plants; 75 acres of mixed large-seeded, foodplants (sedges, smartweeds, millets, beggar-ticks, threesquare, etc.) and 100 acres of other waterfowl food and cover wetland plants (Bacopa sp., pondweeds, Liliaeopsis sp., other submergents, etc.). Shorebird invertebrate density objectives shall be 100 invertebrates/square meter within the 80 acres of Subunit A-1.

Areas in A-Pool that are presently dominated by Phragmites and black needlerush will be converted to perennial emergents. Approximately thirty percent of the wetland areas of this WMU can be enhanced, by a combination of discing, Phragmites control, burning, flooding and drawdowns.

2. WMU B (B-Pool)

At 100 acres, WMU B is less than half the size of A-Pool, but also possesses excellent moist soil management potential. Like WMU A, it is relatively level, with a shallower, higher elevation eastern side and a deeper, lower elevation, western side. The elevation difference is used to roughly subdivide B-Pool along a 1.50' msl bottom elevation into two subunits: B-1 on the east, and B-2 on the west. This dividing line follows a north to south slightly diagonal line, along the length of this pool (Ref. Appendix B1). Subunit B-1 (~35 acres) can be used for managing both migrating shorebirds, and migrating/wintering waterfowl; while Subunit B-2 (~65 acres) may be managed for waterfowl year-round.

Thermo-regulatory habitat in B-Pool is limited to approximately 6 acres of small brush-covered "islands" along the B-1/B-2 Subunit boundary, and the East Dike.

WMU B receives water from C-Storage Pool, via B-Storage Pool to the west. WCS #07 in the B/B-Storage Pools dike, controls the flow into B-Pool from B-Storage Pool. When H-Pool water levels are high enough, B-Pool levels may also be raised with water from H-Pool, via WCS #06 in the East Dike.

Management objectives for WMU B are to produce approximately 20 acres of mixed, fine-seeded waterfowl food-plants; 50 acres of mixed large-seeded food-plants (saltmarsh bulrush, sedges, smartweeds, millets, beggar-ticks, threesquare, etc.); and 15 acres of other waterfowl food and cover plants (Bacopa sp., Potamogetons sp., Lilliaeopsis sp., etc.). Shorebird objectives shall consist of 100 invertebrates/square meter within the 35 acres of Subunit B-1.

Areas in B-Pool that are presently dominated by Phragmites and black needlerush will be converted to perennial emergents. Approximately thirty percent of the wetland areas of this WMU can be further enhanced by a combination of discing, pest control, burning, flooding and drawdowns.

3. WMU B-Storage (B-Storage Pool)

The thirteen acre B-Storage Pool is intended to serve as a water transport system for flooding A and B-Pools, from C-Storage Pool. It permits A-Pool to be flooded without impacting B-Pool. This WMU will normally be managed as a reservoir for A and B-Pools, at higher (~3.0' msl) elevations during the summer, and at the highest possible levels (~4.0' msl) during the winter. It provides brood habitat and limited wood duck nesting habitat in the southwestern corner. Its deeper waters also harbor excellent SAV and fish populations.

Thermo-regulatory habitat within B-Storage Pool is limited to dike edges and about 5 acres of trees and brush along the southwestern side.

WMU B-Storage receives water from C-Storage Pool via the three tubes of WCS #11. It delivers these waters to B-Pool via the single tube of WCS #07; and to A-Pool via the three tubes of WCS #05.

4. WMU C-Storage (C-Storage Pool)

A 45 acre storage pool has been constructed in the center of the impoundment system. When fully operational, water levels of this WMU will normally be managed at approximately 3.0' msl during the summer, and approximately 5.0' msl during the winter. This storage pool is fed by baywaters brought in by

the pumping station, and serves as the reservoir for all impoundments. Water control structures #11, #09, and #08 flow water to the south (B-Storage and A-pools), north (C-Pool), and east (G-Pool, and then to H and J-Pools).

Thermo-regulatory habitat within this WMU are limited to about one acre of dune - shrub islands along the eastern side.

Management objectives for this pool principally revolve around providing water for all impoundments; but also include providing habitat for diving birds, fish, wading birds and SAVs. SAV presences (principally sago pondweed and water milfoil) have been noticed during 1992 and 1993 within the deep ditches of this WMU.

Areas that are dominated by black needlerush and Phragmites will be converted to more useful emergent perennials, although production of fine and large-seeded waterfowl foodplants are not a priority in this pool. About ten acres were treated during 1992 and 1993, by aerial spraying with RODEO, and prescribed burning (Ref. Appendix B5). Most of the needlerush and Phragmites were eliminated then from C-Storage Pool.

5. WMU C (C-Pool)

C-Pool possesses the most acreage, best habitat diversity and most variable bottom elevations of all WMUs. This provides for a greater range of management possibilities. As with A and B-Pools, the eastern side is generally higher than the western side; with the northeastern area being highest, and the southeastern side the lowest. The east-west elevation difference is used to roughly subdivide C-Pool into two subunits along a 1.50' msl bottom elevation: C-1 on the east, and C-2 on the west. This dividing line follows a north to south slightly diagonal line, along the length of this pool (Ref. Appendix B1).

Approximately 75 acres of forested thermo-regulatory habitat exists within C-Pool, throughout most of Subunit C-1 (~60 acres) and northwestern Subunit C-2 (~15 acres). In several instances tree-lines adjacent to managed moist soil management areas in C-1, run east to west - providing excellent wind-breaks for ducks feeding there during the highest-water period in January and February. The marsh edges of these eastern tree-lines were GEMCO-ditched during August 1993, to increase the soil moisture gradient there, improve upon the water flow, and provide additional forage areas for waterfowl, wading birds and shorebirds.

The extensive Phragmites presence along the western side was treated with an aerial application of RODEO during 1992. This treatment was successful, however, wet conditions have kept the dead stems from being burned off since then. Monitoring of these areas and adjacent dikes should continue in order to eliminate recolonization.

WMU C receives water from C-Storage Pool via the single tube of WCS #09 in the C/C-Storage Pool cross-dike. It may also receive water from WMU G, via WCS #12, in the event that the C-Storage Pool supply is inadequate; however, this may impact upon G-Pool water management objectives. WCS #13 allows water from C-Pool to charge D-Pool; while WCS #14 drains C-Pool into the bay during draw-downs.

C-Pool's management objectives mirror those of A & B pools. Subunit C-1 (~80 acres) can be managed for both migrating shorebirds, and migrating and wintering waterfowl; while Subunit C-2 (~110 acres) can be managed for year-round waterfowl use. C-Pool objectives include the production of approximately 30 acres of mixed, fine-seeded, and 70 acres of mixed large-seeded, waterfowl food-plants, together with 70 acres of other waterfowl food and cover wetland plants (Bacopa sp., Potamogeton sp. and other SAVs in low areas). Shorebird objectives shall consist of 100 invertebrates per square meter within the 80 acres of Subunit C-1. Areas in C-Pool that are dominated by Phragmites and black needlerush will be converted to emergent perennials.

Approximately 20% of the wetland areas in this WMU can be enhanced by a combination of disking, Phragmites control, burning, flooding and drawdowns.

6. WMU D (D-Pool)

This small (17 acres) WMU is currently the least developed, but with good management potential, since it is relatively level, with a shallow grade from west to east. The higher eastern side is relatively moist for most of the year, but dry during the summer; while the western side is wet to moist throughout the year. Further development, including raising existing dikes/roads, are needed before D-Pool can hold the higher water levels necessary to fully convert it into a functional management unit.

Thermo-regulatory habitat is limited to the deep ditch along the western side, which runs north to south.

Water is supplied to D-Pool's western deep ditch from WMU C via WCS #12, in the C/D cross-dike. Some moist soil and SAV plant species began appearing along the western side during 1992 - 1993, in response to maintaining higher water levels. This WMU was disced during 1992, to control upland plants (Panicum spp.) in the eastern half (Ref. Appendix B5). It was GEMCO-ditched during August 1993 to increase water circulation, improve upon the moisture gradient, and provide additional forage for waterfowl, shorebirds and wading birds.

Current objectives for this WMU include holding as much water as possible and observing vegetation response. Emergent wetland plant species, SAV and Bacopa sp. will be encouraged. Phragmites and black needlerush will be controlled. If adequate water levels cannot be maintained to support SAV and emergent wetland plant production, waterfowl food-plants should be planted during the spring (millet, milo, Lespedeza bicolor along the eastern periphery, etc.) and a subsequent flooding regime employed that permits waterfowl access during the winter.

The development of this WMU, in close proximity to the Refuge Headquarters/Visitor Contact Station will provide an excellent "watchable wildlife" viewing area for the public. If development of this WMU is completed, the objectives should be rewritten to include similar moist soil management practices as those used for A, B and C-Pools; including maintenance of higher water levels than currently possible during the winter, to feed waterfowl and shorebirds. At that time, percentages of this WMU should be assigned to the production of large-seeded and small-seeded waterfowl food-plants, and invertebrate densities for shorebird use.

Approximately 80% of this WMU can be improved by a combination of discing, Phragmites control, burning, flooding and drawdowns.

7. WMU E (E-Pool)

This small (25 acres) WMU consists of a lower northern end, and a higher southern end. The northern end is the most manageable half, since it holds water and supports a good mix of large-seeded waterfowl food-plants. The proximity of this unit to the headquarters building and visiting public precludes frequent use by significant waterfowl populations. However, enough duck and snow goose use occurs to make this unit an excellent "Watchable Wildlife" station for the visiting public, and an outdoor classroom for school groups at which moist soil management practices can be interpreted by Refuge staff.

Further improvements to WMU E are needed for the southern half to become a fully operational moist soil management unit. Flooding possibilities there are limited by the low dike/road to the west. It needs raising, since it often washes over during the high-water period in winter, requiring the discharge of water from this WMU before the soils of the southern end are adequately saturated.

Water is provided to WMU E via the single tube of WCS #15, from WMU D. This unit was GEMCO-ditched during August 1993 (Ref. Appendix B5) to improve water circulation, increase the moisture gradient, and provide additional forage for waterfowl, shorebirds and wading birds. An existing old screw-gate (WCS #16) is partially inoperable, but still capable of drawing down this unit. It will be replaced in 1994 with the standard flashboard type, single-tubed WCS used throughout the Refuge.

Objectives for WMU E include holding as much water as possible during the winter and drawing down in the spring. Production goals are approximately 15 acres of large-seeded, waterfowl food-plants (northern end) and 5 acres of fine-seeded, waterfowl food-plants (southern end). The wetter northern end should be periodically disced (about every three years) and/or burned during the late summer - early fall. The drier southern end should be disced annually until colonization by moist soil plants occurs; then it should be disced when the northern end is.

Areas in E-Pool that are dominated by upland and dune grasses should be converted to emergent wetland plants. Approximately 50% of this WMU can be enhanced by disking, flooding and drawdowns, and raising of the dike/road.

8. WMU F

Water management of this unit is very limited and continues to be totally weather dependent. The borrow ditch along the eastern side seldom goes dry, and supports a good fish population that is utilized by large wading birds. However ditch water levels seldom reach the top or overflow, making soil saturation of the adjacent lands and subsequent moist soil management unlikely. Should the ditch overflow for a prolonged period, it would threaten the paved entrance road with washouts. No water control structures exist in this unit. Therefore, the water management potential for WMU F is very low.

Most of this WMU is dominated by waxmyrtle shrubs and dense panic grasses. A few small "potholes" exist along the marsh - dune interface that support small duck numbers during the fall, winter and spring, and provide some (~5 acres) thermo-regulatory habitat. This WMU was drum-chopped in 1985. A one acre block of dense waxmyrtle was hydroaxed in 1993, next to the entrance road. The entire unit needs periodic disking and burning on a three year rotation, to discourage reestablishment of waxmyrtle and encourage more desirable vegetation. Black needlerush stands along the marsh edges should be burned during the winter, on a three year rotation, to provide snow goose access to its rootstocks and encourage germination of more desirable waterfowl food-plants. Phragmites should be controlled with the herbicide RODEO.

The development of this WMU, in close proximity to the Refuge Headquarters/Visitor Contact Station, will provide an excellent "watchable wildlife" viewing area for the public.

Until the access road is moved and/or raised, additional management of this WMU may not be possible.

9. WMU G (G-Pool)

This northernmost "dune pool" is relatively new with good moist soil management potential. It maintains higher ground elevations than Pools A through F, and is in need of further development. The steeper east to west grade in this narrow pool is due to the dune complex along the eastern side. Moist soil management potential is greatest in the lower-elevation southern half that stays wet the longest. The higher-elevation northern half is currently dry for most of the year; it is wettest during the winter. The amount of moisture that the northern end receives needs to be increased for a conversion to wetlands plants to occur. This means increasing the period of soil saturation (maintaining higher water levels) during the growing season and conducting a slow draw-down in the spring.

The northern half of G-Pool should be managed principally for shorebirds, since it will be shallowest when flooded. The southern half should be managed for both waterfowl and shorebirds, since it will be deeper when flooded.

WMU G receives its water from C-Storage Pool via WCS #08. Its waters can be transferred into H-pool at WCS #17, in the G/H cross-dike. WCS #12 provides for the draining of G-Pool into C-Pool, for spring draw-down purposes, or in an emergency when water is needed for the higher priority C-Pool.

The current vegetation composition in this WMU is primarily upland species. Approximately 70% of G-Pool can be enhanced by converting to moist soil vegetation. Such a conversion will involve combining the above water management recommendations with spring and/or fall disking, root-raking in hydroaxed areas, RODEO applications to Phragmites concentrations, and burning. Areas dominated by Phragmites, upland grasses and black needlerush will be converted to emergent wetland plants.

Thermo-regulatory habitat is common throughout the eastern side of WMU G, where sand dunes and the most waxmyrtle and live oak exists. It totals approximately 35 acres. However, this habitat generally provides protection from east winds only. Additional protection from north and west winds will be available in the hydroaxed blocks during the winter months, when they are flooded.

The live oaks occupying the higher ground within the pools must be retained because of their critically needed acorn crop value. All hydroaxe operations must avoid removal of live oaks. The acorn crop is very important during January and February when pool water levels are highest and afford waterfowl access to this high carbohydrate food during the coldest time of year. Many other wildlife species also utilize this food, including deer.

The deep-water ditch along the western side of WMU G provides water to the rest of the Pool through sheet-flow, after it overflows. Several GEMCO-ditches were dug during August 1993, along the western borders of three 5-7 acre hydroaxed blocks, that tie into the deep ditch (Ref. Appendix B5). Although the ditching targets were the hydroaxed blocks, the presence of many stumps and a berm pushed up by past root-raking operations, prevented ditching there. The ditches were dug to improve water circulation and the moisture gradient in drier areas, and to provide forage areas for waterfowl, shorebirds and wading birds during drawdowns.

Future plans should include disking the hydroaxed sites (avoiding the live oaks left standing), and extending existing GEMCO-ditching into all three hydroaxed sites. If, after 2 - 3 years of decomposition and disking, the GEMCO is still unable to ditch the hydroaxed sites, the Refuge backhoe should be used to excavate the ditches. Water levels should not be drawn down beyond the point where 6" remains in the GEMCO-ditches, unless an emergency need for water arises in C-Pool.

Management objectives governing production of waterfowl food-plants can not be set at this time, since suitable habitats have not yet been developed, and the amount of suitable habitat that can be developed can not yet be predicted. Shorebird objectives shall consist of 100 invertebrates per square meter throughout the wettest 40 acres of this unit.

10. WMU H (H-Pool)

This middle "dune pool" is also relatively new, with limited moist soil management potential. The dune complex along the eastern side creates a steeper east to west grade. Moist soil management potential is greatest in the northern (~10 acres) and the southern (~10 acres) end, where the ground elevations are lowest, and moist soil vegetation has recently (1991) become established. The northern end currently has the best waterfowl and shorebird habitat. The central 45-50 acres are primarily dune and upland habitats, most of which are above floodable elevations. Therefore, management in this WMU should focus on the northern and southern ends.

Both ends should be managed for shorebirds and waterfowl; however, the amount of bird use of the more exposed northern end will be affected by the level of adjacent public use along the East Dike road.

Thermo-regulatory habitat consists of these same northern and southern ends, since they are sheltered from all wind directions by dunes, dikes and vegetation.

WMU H receives its water supply indirectly from C-Storage Pool, through G-Pool via WCS #17, in the G/H cross-dike. Its waters can be transferred to J-Pool via WCS #18, in the H/J cross-dike. WCS #06 provides for the draining of H-Pool into B-Pool, for spring draw-downs, or in an emergency when water is needed for the higher priority B-Pool.

The vegetation composition in this WMU is primarily upland species, with waxmyrtle, live oak and panic-grasses predominating, except for the northern and southern ends. The northern and southern ends supported good stands of large-and small-seeded waterfowl food-plants during 1993. Consistent flooding during the winter, slow draw-downs during the spring, and maintaining moist soils during the summer, need to be continued to encourage emergent wetland plant species, and discourage upland species in the lower elevations. Leveling of sandy mounds and discing will also assist in the conversion to wetlands. Phragmites concentrations need to be controlled with RODEO applications and burning.

Two (one-three, and one-five, acre) blocks of dense waxmyrtle were hydroaxed during June 1992 (Ref. Appendix B5). Those blocks need disking to aid woody decomposition and the conversion to additional moist soil units.

The live oaks occupying the higher ground within the pools must be retained because of the importance of their acorn crop, as a critical food source here; particularly during the colder months when pool levels are highest and provide waterfowl with access to this food.

The deep-water ditch along the western side of WMU G provides water to the rest of the Pool through sheet-flow, after it overflows. During August 1993, the wetlands immediately adjacent to the three hydroaxed blocks were GEMCO-ditched, to provide better water circulation and improve the moisture gradient in the eastern side of this WMU (Ref. Appendix B5). The presence of many waxmyrtle stumps and a berm from previous root-raking operations, prevented any ditching within the hydroaxed sites. However, such ditching should be carried out in those hydroaxed sites, after two or three years of slash decomposition and disking. If the GEMCO is still unable to do the work, then the Refuge backhoe should be used. Water levels in those ditches should not be allowed to drop below a 6" depth, unless an emergency need for water arises in B-Pool.

Shorebird objectives shall consist of 100 invertebrates per square meter within the wettest 30 acres of this WMU.

11. WMU J (J-Pool)

This southernmost "dune pool" is the newest pool, with limited moist soil management potential, due to higher ground elevations. It is in need of further development. Like G and H-Pools, it maintains a steeper east to west grade because of the dune complex to the immediate east. The northern half is generally slightly lower and wetter than the southern half, making the northern half best suited for moist soil management. However, with consistent maintenance of higher water levels in this pool during the growing season, much of the southern half could also be converted to wetlands. Much of the southern half is dry throughout the year; although about 50% is usually underwater during late winter.

The lowest elevations in the southern half supported about 5 acres of a new, unknown, large-seeded plant during 1993, (suspected to be Sacciolepis striata). Waterfowl use of this area needs to be monitored to determine whether this species should be managed for, or controlled. The shallower, southern

half should be managed for shorebirds, while the deeper northern half should be managed for both waterfowl and shorebirds.

Thermo-regulatory habitat is common throughout the eastern side during the winter, when this pool is flooded. Approximately 55 acres of this habitat type exist in WMU J. Waxmyrtle, live oak and panic grasses are the dominant vegetation types there. All live oaks within J-Pool are to be protected. Their annual acorn crop is a very important wildlife food in this area. Any hydroaxe operations must avoid removal of live oaks. Wooded swamp habitats (ie. red maple, black gum, sweetgum, etc.) must also be avoided during any hydroaxe operations.

WMU J receives its water supply from C-Storage Pool, through G and H-Pools. Water transfer into J-Pool occurs at WCS #18 in the H/J cross-dike. WCS #03 provides for draining of J-pool into A-Pool, during spring draw-downs, or in an emergency if water is needed for the higher priority A-Pool.

Since the current vegetation in WMU J is primarily upland species, more work is needed to convert additional acreage to moist soil species. Maintaining higher water levels during the growing season and slow spring draw-downs, must be combined with spring and/or fall disking, RODEO applications to Phragmites concentrations, and burning.

The deep-water ditch along the western side provides water to most of this pool through sheet-flow, after it overflows. Several west to east, GEMCO-ditches should be dug along the lower edge of higher elevation areas in the future; to increase the moisture gradient in those drier areas, provide increased water circulation, and provide additional forage areas for waterfowl, wading birds and shorebirds during draw-downs. As with the other pools, water levels should not be lowered below a 6" depth in those GEMCO-ditches, unless an emergency need for water arises in A-Pool.

12. WMU K (Long Island, Ragged Island and Western Islands)

This complex of islands and "marsh fingers" (the western edge of the barrier spit), consists of 2,300 acres of emergent wetlands, waterways, potholes and open water, 55 acres of farmed and old fields (Long Island), and 70 acres of hardwood forest (50a.- Long Island and 20 - Ragged Island). Active water management within this WMU does not exist, and may not be needed; since Ragged Island's coves attract thousands of ducks and geese every fall, winter and spring, while the potholes in western Long Island attract several hundred.

In the past, adequate Canada goose feeding habitat existed off-refuge throughout the Back Bay Watershed. Recent conversions of farmland into housing, and the resulting impacts from the expanding human population, is resulting in a decline in Canada goose feeding habitat. Wintering Canada goose populations have dramatically declined in the Back Bay area over the past decade.

The Long Island fields have the potential to replace some of this lost habitat. They should be managed for Canada and snow goose browse. Canada goose browse in the fields of Long Island has been promoted in the past through co-operative farming for winter wheat and ladino clover. Snow goose response has been good during 1991 - 1993. This co-operative farming program should continue, and expand into the two ten-acre fallow, old fields at the northern and southern ends of the island. Such an expansion will require brush-hogging, plowing, disking and planting programs.

The most important resource in this WMU is the submergent aquatic vegetation (SAV) population. Populations of this important waterfowl food have been sparse since the late 1970's. During 1992-1993, dense populations have become evident in Ragged Island, the "marsh fingers" and Long Island waters. Ragged Island's many coves support the greatest populations. These areas appear to be expanding concentrically. Monitoring the SAV populations and their spread, through permanent transect points, should be a part of the management program for WMU K.

Other management in WMU K should include continued burning of black needlerush concentrations about every three years to expose its rootstocks for snow goose use. Phragmites populations are extensive on many islands in this unit, and require eradication with RODEO, and subsequent burning of the dead stems.

13. WMU L (North Bay Unit)

This largest WMU (~3,200 acres) includes a complex of emergent marshes, interconnected potholes, farmland, Black Gut, Hell Point Creek, man-made ditches, as well as both upland and bottomland mixed hardwood-softwood forests. The 2,020 acres of this WMU that make up the North Bay Marshes Natural Area and the Black Gut Natural Area, house rare bird, plant and insect species that require careful consideration prior to undertaking any management actions in those areas.

Active water management within this WMU does not yet exist. However, there is potential for wetlands restoration work on large farmland tracts (ie. tract #125a). Such restoration work should include reforestation with unique forest habitats (ie. bald cypress, white cedar, green ash, etc. forests, or mixes of those species), and shallow impoundments construction where wet conditions already exist. Drier farmland should also be managed for goose browse, if far enough away from disturbances posed by nearby road traffic and people. These goose browse areas need to be open and large enough to encourage geese to land there. Such goose browse management should be carried out through the existing Refuge Co-operative Farming Program.

Wooded swamps with open water potholes or ponds on both sides of Sandbridge Road, should be managed for wood duck production within reasonable limits, since Back Bay NWR is not a waterfowl production station. Nestboxes should be placed singly, in woods edges and not over open water, to discourage dump-nesting and use by passerines. Paired boxes are inefficient and not to be used.

In the more upland areas, especially north of Sandbridge Road, hardwood and softwood stands may be managed using timber stand improvement (TSI) techniques developed by the U.S. Forest Service and the State of Virginia's Forestry Department. Assistance from one or both agencies should be acquired prior to initiating and implementing management recommendations.

Dense black needlerush stands could be periodically burned off, about every three years, to provide snow goose forage, and encourage colonization of those areas by desirable waterfowl food-plants. However, prior to establishment of such a policy, the impact to rail and bittern production and their use of those areas must be analyzed. Significant negative impacts to those species will be justification to abort such a burn program. Phragmites stands are present and must be eliminated through aerial RODEO applications, and subsequent burning.

14. WMU M (Beggar's Bridge Unit)

This 1,800 acre WMU includes the Muddy Creek and Porpoise Point Natural Areas; most of which are excellent emergent marsh and open-water pothole habitats with connecting ditches - ideal for waterfowl use. Because of the rare plant and bird species there, management actions should be carefully assessed to insure that those species are not negatively impacted.

Active water management within this WMU does not yet exist. There is potential for wetlands restoration work on some farmland that has been, or will be, acquired. As with WMU L, such restoration work should take the forms of reforestation with unique bottomland softwood and/or mixed softwood-hardwood habitats, and shallow impoundment construction where wet conditions already exist. Tract 192, to the west of Bridge Cove, has excellent potential for impoundment development; since it consists of cleared farm fields surrounded by roads that can be raised and formed into levees or dikes, with associated WCSs.

Drier farmland should be managed for goose browse, if far enough away from disturbances posed by adjacent road traffic and people. These browse areas should be open and large enough to encourage geese to land there. Such goose browse management should be carried out as part of the existing Refuge Co-operative Farming Program.

A significant amount of wooded swamp and open pothole habitats exist along the western side of WMU M. Such habitats are used by wood ducks, mallards, black ducks and both teal species. Management efforts should focus on providing a limited wood duck nestbox program aimed at replacing the existing private nestbox program (using the recommendations in section 13 above), and assessing the need for water control in waterfowl concentration areas.

Other management in WMU M could include the burning of black needlerush concentrations about every three years, to provide snow goose forage and encourage colonization of those areas by more desirable waterfowl food-plants. However, prior to establishment of such a policy, the impact to rail and bittern production and their use of those habitats must be analyzed. Significant negative impacts to those species will be justification to abort such a burn program. Phragmites concentrations along the shorelines of this WMU, particularly around Bridge Cove, must be eliminated through use of aerial RODEO applications, and subsequent burning.

15. WMU N (Nawney Unit)

This 1,400 acre WMU includes the 610 acre Nawney Creek Natural Area. Because of the rare plant, Liliaeopsis attenuata, found there, management actions need to be carefully assessed, to insure that they do not negatively impact this species. Most of this WMU's habitat consist of emergent marshes, open water coves and potholes, and creek/bay shorelines - all excellent waterfowl habitats.

Active water management does not yet exist in this WMU. It is also possible that such management may not be necessary. There is potential for wetlands restoration work on some farmland that has been, or will be acquired. As with WMUs L and M, such restoration should take the form of reforestation with unique bottomland softwood and/or mixed softwood-hardwood habitats, and shallow impoundment construction, where wet conditions already exist.

Drier farmland should be managed for goose browse, if far enough from disturbances posed by adjacent road traffic and people. These browse areas should be open and large enough to encourage geese to land there. Such a goose browse management program should be carried out as part of the existing Refuge Co-operative Farming Program.

Significant shrub/wooded swamp and pothole habitats exists within this WMU. Such habitats are used by wood ducks, mallards, black ducks and teal. Management efforts should focus on providing a limited wood duck nestbox program aimed at replacing the existing private nestbox program (using the recommendations of section 13 above), and assessing the need for water control in waterfowl concentration areas.

Other management in WMU N could include the burning of black needlerush concentrations about every three years, to provide snow goose forage and encourage colonization of those areas by more desirable waterfowl food-plants. However, prior to establishment of such a policy, the impact to rail and bittern production and use of those areas must be analyzed. Significant negative impacts to those species will be justification to abort such a program. Phragmites concentrations exist along the shorelines in several locations along both Nawney Creek and Redhead Bay, and must be eliminated through use of aerial RODEO applications, and subsequent burning.

F. Management Techniques

Management practices employed to improve Refuge habitats for migratory birds, include soil treatments (root-raking, disking and planting), prescribed burning, mowing, and pest plant control. Table #4 below summarizes some of Back Bay NWR's major habitat improvement efforts during the last seven years. Maps included in Appendix B4 provide specifics on sites of these practices.

TABLE #4 - 1987-1993 Habitat Management Actions

<u>Activity</u>	<u>Acres Treated</u>						
	1987	1988	1989	1990	1991	1992	1993
Prescribed Burning	130	30	60	135	540	300	45
Discing/Root-raking	167	0	45	120	65	175	61
Mowing	0	0	40	40	34	35	10
Pest Plant Control	10	50	0	0	150	175	105
Planting	0	0	0	75	34	5	0
Hydroaxing	0	0	0	0	0	30	3

Further discussion on the results of the above management actions can be found in Section IV.C. of this Plan. Specifics on these management actions follow.

1. Pest Plant Control

Herbicides will be used separately or in conjunction with other techniques (water control, mowing, discing, burning, etc.) to control undesirable vegetation such as Phragmites. Refuge goals currently consist of RODEO application to a minimum of forty acres of Phragmites each year. By treating at least forty acres per year, Phragmites will eventually be controlled on the Refuge.

At Back Bay Refuge, Phragmites is the only exotic marsh plant that cannot be controlled by non-chemical methods. It has become more of a problem during 1992 - 1993, with major new land acquisitions along the western side of Back Bay. Many of the wetlands recently acquired, and soon to be acquired already have dense populations of this pest well established. Phragmites removal has been shown to greatly increase habitat biodiversity and migratory bird use of infested lands.

During September 1992, all Phragmites concentrations on existing and soon-to-be acquired Refuge lands were mapped, using recent (April 1990) aerial photographs. These two maps were incorporated into a new Refuge Phragmites Control Plan during October 1992. That plan briefly identifies Refuge objectives, past and present control programs, the future control program and associated costs for continuing programs.

Control continued during September 1992, using aerially applied RODEO, to high priority stands within the Refuge impoundments. Checks of treated areas were conducted during September and October of 1992. The September checks did not reveal a significant mortality, and fears were that the helicopter contractor had missed much of the target because of

winds; however, the October checks revealed that a major die-off had occurred. General mortality estimates were 90%. This evaluation was summarized in an October 22 memo to the Regional office, that included maps of treated areas and kill ratios.

The potential for Phragmites expansion exists, especially in areas with disturbed soil (ie. new dikes) from construction activities. Application rates and areas to be treated are addressed in annual pesticide application proposals and the Annual Marsh and Water Program. Future control efforts will focus on the following priorities:

Priority 1 - Remaining live Phragmites stands within and adjacent to the impoundments.

Priority 2 - Phragmites stands in WMU K (Ragged, Long and Western Islands).

Priority 3 - Phragmites stands on newly acquired lands. This priority may change upon the discretion of the Project Leader, should newly acquired land have particularly good waterfowl and State rare species habitat that is threatened by the Phragmites presence.

2. Burning

Prescribed fire is a Refuge management technique commonly used to set back vegetational succession, either by itself or in conjunction with other techniques. Burning rapidly oxidizes and returns nutrients to the soil from the undecomposed duff layer. Burning Refuge marshes and fields also improves food availability for migrating waterfowl. Black needle-rush stands are common at Back Bay Refuge; and snow and Canada geese feed upon its tubers once the bayonet-like upper plant is removed.

The Back Bay NWR Fire Management Plan and associated annual prescriptions are designed to complement the Marsh and Water Management Plan and improve Refuge habitat for wildlife. All burns undertaken as part of the Marsh & Water Management Plan, and the Annual Water Management Program need to follow the guidelines of the Fire Management Plan and the Annual Fire Prescriptions/Fire Management Program.

The Fire Management Plan recommends the burning of at least 700 acres of natural marshes (mostly bay islands where burning may be the only habitat management technique available) and impoundments per year. Most of these prescriptions are designed for a three year burn rotation, during which all of

the land identified for burning is treated. Achieving Refuge fire management goals will significantly contribute to reaching the Refuge objectives outlined above.

Evaluation of the burn program to determine whether the prescribed burns are accomplishing the above stated goals should be well documented in the Annual Marsh and Water Program. The burn itself must also be documented in the fire report to be completed immediately after each burn.

Although a spring controlled burn is desirable within pools with dead Phragmites stands, it will not be practical if waterfowl foodplants and invertebrates are to be properly managed for. Water levels along the lower western sides, with the most Phragmites presence, cannot be lowered to the optimum level for a good burn, without drying out the substrate along the higher-elevation eastern sides of A-, B- and C-Pools. Such a drying out during the spring would negatively impact those high waterfowl and shorebird use areas in the following ways:

- a. Soil invertebrates, a critical food source, would be killed off.
- b. Germinating and resprouting, desirable moist soil plants would be destroyed.
- c. Undesirable plants such as broomsedge, fennel and panic-grasses could become established.
- d. The spring (April) waterfowl migration would be denied use of the eastern areas, and parts of the western areas.
- e. The spring (May) shorebird migration could be denied use of those eastern and western areas, unless water levels are raised quickly after the burn. However, with the invertebrate population diminished, adequate food may not be available.
- f. The current (draft) Annual Water Management Program calls for providing only a partial drawdown during March -April, to provide the spring waterfowl migration with access to invertebrates and seeds previously denied by deeper water, and to provide new edge for early spring shorebird migrants.

Because of the above concerns, burning during April is not practical. Water levels will be low enough to conduct a controlled burn during May. However, such a burn would probably also consume the nests of bitterns, rails, ducks and songbirds, and should be discouraged. The only alternative remaining is to conduct all controlled burns within all impoundments/pools during August through mid-October, when all

nesting is completed, water levels are still low enough, and burned areas would provide forage for the fall waterfowl and shorebird migrations.

Controlled burning in areas outside these pools can occur, however, during winter through early spring, and is recommended during January through March, prior to the nesting season, in those areas with dense dead Phragmites and/or live black needlerush stands.

With the Refuge land acquisition program adding lands along the western side of Back Bay, revisions to the Refuge Fire Management Plan will be needed to manage the new habitats and habitat types. Such revisions should include:

- a. New habitat types and acreage per habitat type acquired.
- b. New proposed burn sites and acreages involved.
- c. Benefits of burning those areas, to the wildlife resource, and burning frequency.
- d. When, and how frequently, follow-up burn evaluations are to be performed.
- e. Sensitivity of State Natural Areas in WMUs L, M and N, as well as the sensitive species therein; whether burning will impact those species, and how.
- f. Water Management Plan impacts to Fire Management Plan, and actions needed for both to work efficiently.
- g. Contacts with adjacent private landowners and possible cooperative burn programs between them and the Refuge.

3. Soil Treatments

Mowing, disking and root-raking are techniques that can be used individually, together, or in conjunction with other techniques (water control, burning, etc.) to manipulate vegetation.

The Annual Marsh and Water Management Program will be written so that appropriate WMUs are treated periodically. Some areas (ie. dikes and goose browse fields) may need to be mowed annually; while other fields and moist soil areas may need mowing and/or disking every 2 - 3 years. Mowing and disking rotation periods help in the control of undesirable vegetation; maintain wintering waterfowl habitat with quality emergent vegetation; and make additional food (i.e. tubers) available to wintering geese.

Discing of moist soil units has been one of the most effective tools at Back Bay Refuge, to remove undesirable plant species, while also encouraging invertebrate production. Encouragement of invertebrates and germination of desirable moist soil vegetation occur simultaneously during the spring and early summer, if an inch of water is put back over the area immediately after discing. Discing alone will reduce the density of an undesirable species, but if the disced vegetation is not covered with water, resprouting will occur during the summer, especially with black needlerush. Therefore, when working in moist soil management units, it is advisable to pair discing with shallow flooding whenever possible, and at any time of year.

Only shallow discing should be employed in such moist soil programs, since deep discing may bury desirable seeds too deep for germination. Discing for pest plant control (black needlerush and upland panic grasses) may need to be done annually until the undesirables disappear. However, discing for moist soil vegetation and invertebrate management should only be done every 2 - 3 years, or less, if the diversity and densities of the desirable plants and invertebrates remain high. Annual vegetation transect data should be analyzed to help determine this. Too frequent discing can reduce the densities and diversities of the vegetative and invertebrate communities that arise, and actually reduce production. This needs to be avoided (even if the short-term snow goose response is spectacular).

Root-raking is principally a tool for removing undesirable root and stump presences. Although it was used extensively during development of the impoundment complex, it is a slow, time-consuming process that should be avoided when possible. It usually removes the topsoil and nutrients from a site, leaving a relatively sterile substrate behind. Hydroaxed areas should be cut as low to the ground as possible, and be disced and flooded after hydroaxing, to increase the decomposition rate of woody slash remaining. Such decomposing debris should add to the nutrient base of the sandy soils. Root-raking of hydroaxed sites is not recommended.

Annual programs should focus on what areas should be burned, mowed, disced, ditched and/or hydroaxed, and how often. As a result, interactions with other Refuge plans and annual programs will occur. Coordination with and integration of the objectives and practices of the Upland Habitat, Fire Management and Co-operative Farming Plans/Programs will therefore be required.

4. Water Control

Water control techniques generally consist of gradual flooding in the late fall and winter, and gradual draw-downs in the late winter and spring. As emphasized in Section C, and other parts of this plan, slow water level changes (~2" per week) are the recommended water control tool for use at Back Bay Refuge, unless emergency needs mandate otherwise. Sudden draw-downs will probably result in a significant bait-fish and snail mortality. Sudden changes in water levels, of several inches or more, will also probably negatively impact the vegetational and invertebrate communities present. Sudden draw-downs are to be avoided, unless the water can be replaced rapidly before the substrate has warmed/chilled and begun to dry out.

Annual Water Management Programs must be well thought out and adequately document the preceding year's programs; especially during the "trial and error" days following completion of the impoundment rehabilitation project. Program objectives should provide water levels that result in the maximum desirable emergent vegetation and invertebrate growth in all WMU's.

General guidelines should revolve around gradually drawing-down an impoundment in the spring; holding water levels low during the summer; and gradually raising levels in the late fall. Water level fluctuations should coincide with shorebird and waterfowl migrations, so that the proper habitat required for the target species is available (ie. - wet edges and mud-flats, with ~1" water and high invertebrate presences for shorebirds; and ~4" water and high waterfowl food-plant densities for mallards). Emergent foods such as saltmarsh bulrush, three-square, water hyssop (Bacopa sp.), smartweeds and spikerushes will increase, as will SAVs in deeper ditches, under this type of water management scheme.

Permanently higher water levels should be maintained in the two storage pools. These higher water levels should eventually convert most vegetation therein to SAV; making those pools appealing to fish, diving birds (coots, grebes, cormorants, etc.) and wading birds. It is important that adequate water volumes be available in the two storage pools during the summer and fall, to flood other WMUs after discing, burning, hydroaxing, or other management actions are completed.

A "staggered" water management scenario should be employed over several years, through the Annual Water Management Program, so that the same WMU is not following the same

program of the prior year. Natural water systems have flooding regimes that differ among seasons and years. "Repetitive manipulations scheduled for specific calendar dates, year after year, often are associated with declining productivity. Management assuring good production over many years requires variability in drawdown and flooding dates among years." (Fredrickson, 1991).

Impoundment conditions must be re-evaluated annually, so that the water levels prescribed in the Annual Water Management Program make food-plants and invertebrates available for wintering waterfowl, and fall/spring shorebird and waterfowl migrants, at the optimum feeding depths.

G. Monitoring & Evaluation

In order to determine whether the annual water management programs are working or not, migratory bird use and production goals must be periodically monitored and evaluated. Therefore, migratory bird surveys, vegetation transect data and invertebrate sampling data must all be considered important evaluation tools for determining whether the Water Management Plan and Annual Water Management Program are working. Low migratory bird use, low desirable vegetation densities and/or low invertebrate populations are all indications that current water management practices may not be working, or that more time may be required for water management impacts to be felt by those communities.

During the summer of 1993, 35 permanent vegetation grid-points were established in A-Pool and 30 in B-Pool. Each permanent point consists of a five foot fiberglass pole, with the point's code inscribed into it at the top. Each point is 300' apart in B-Pool, and 400' apart in A and C-Pools. Thirty-five permanent vegetation grid-points are scheduled to be set in C-Pool during the summer of 1994.

The purpose of these data points is to annually monitor vegetation species and densities within the three principal WMUs every September. Data from the vegetation grid-points will provide trends needed to determine if water management efforts are succeeding, or not. Grid-points data are also entered into the Refuge VEGDATA computer program. This program's data can also be loaded into the new Refuge MOIST SOIL ADVISOR computer program, that is programmed to analyze data from previous years' data, and provide guidance in setting future moist soil management programs. These two programs should be used in setting up future Annual Water

Management Programs, and tracking vegetation trends from year-to-year. Vegetation grid-points data were collected for A and B-Pools during 1993.

Vegetation grid-point data will also provide the number of points containing large-seeded and small-seeded food-plants. Extrapolation of this data to the entire WMU will provide an estimate of whether the acreage goals set for the WMU in this Plan, are arrived at for each plant group. Vegetation transects carried out in 1985 are contained in Appendix A1 for reference and comparison with more current data.

During the September vegetation grid-point surveys, invertebrate surveys should also be conducted at consistent intervals from the permanent grid-point stake. Invertebrate surveys are relatively simple to carry out. Guidance is provided in Fredrickson and Reid's "Initial Considerations for Sampling Wetland Invertebrates" (1988), in the Refuge "Waterfowl Management Handbook" looseleaf binder. The objective invertebrate density is 100 invertebrates per square meter, or more.

Weekly waterfowl and other bird (wading bird, marsh & waterbird, shorebird and raptors) surveys will provide good migratory bird use trends useful in analyzing water management program responses. During these surveys, migratory bird use of areas treated (ie. disced, hydroaxed, burned, Phragmites eliminated, etc.) within three years should be indicated on the field survey forms used to record population data. This information should also be entered into the VEGDATA program, under "Notes".

During the past 10 - 15 years, four SAV transects have been intermittently run throughout Back Bay by personnel of the Virginia Department of Game & Inland Fisheries. This transect data needs to be obtained and added to Refuge records. The Refuge had also been tracking SAV populations on an intermittent basis during the late 1970s and early 1980s, when milfoil (Myriophyllum spicatum) was expanding into this area. With the decline of SAV in Back Bay, this tracking was discontinued. However, the present SAV increases are encouraging, and merit renewed tracking.

The Virginia Department of Game and Inland Fisheries has also been monitoring Back Bay water quality parameters at 22 locations; however, this monitoring is only done once or twice a year. The Back Bay Restoration Foundation (BBRF) has been part of a water monitoring program that measures water quality parameters at several points in Hell Point, Muddy, Beggar's Bridge, and Nawney Creeks for about five years. Monthly

samples are collected by BBRF members and transported to the Virginia Water Control Board, which provides testing for individual parameters.

In 1989 the Refuge began performing weekly water quality sampling of Back Bay at the headquarters boat dock, as part of the Albemarle-Pamlico Estuarine System's (APES) Citizen Water Quality Monitoring Program. Testing parameters include: turbidity, temperature, pH, dissolved oxygen, total nitrate, total phosphate, and salinity. Data is forwarded to the APES office at East Carolina University, ICMR, Mamie Jenkins Building, Greenville, North Carolina 27858-4353 (919-757-6220/6752), where it is computerized and combined with data from other monitoring stations throughout the coastal APES area.

Additional monitoring/evaluating should also include the following programs:

- a. Cover-mapping of the entire refuge, with eventual incorporation into a Refuge Geographic Information System (GIS) computer program.
- b. Twice weekly water gauge readings from each impoundment (WMUs A through J).
- c. Graph water regimes for each impoundment, as part of the Annual Water Management Program.
- d. Maintain an annual record of land management techniques (i.e. burning, disking, planting, etc.) carried out within each WMU. Maps of those areas illustrating the affected areas would suffice.

The above evaluations and monitoring will require a biological team of at least one PFT Refuge Wildlife Biologist, one PFT Biological Technician and two seasonal Biological Aids.

Annual marsh and water programs will not only evaluate the past year's efforts and direct management plans for the upcoming year, but will also provide guidance on what evaluation/monitoring techniques should be implemented during the upcoming year. The 1990 Water Management Program is attached in Appendix D for reference.

H. Contingency Planning

In the event of a major disruption to the wetland ecology of Back Bay Refuge, contingency planning must already be in place. Two natural events that could negatively impact our system include:

1. A major overwash of the freshwater impoundment complex by the ocean.
2. A sudden, significant movement of migratory bird numbers into the Refuge, due to a serious, prolonged freeze in their more northern wintering grounds.

A major overwash of one or more impoundment(s) could occur during a storm, hurricane, or tornado event, since the Atlantic Ocean is just a few hundred yards east of the impoundment complex. All three weather events have occurred in this area in the past. WMUs G, H and J stand the greatest chance of being overwashed. Prolonged inundation by saltwater will probably destroy the ecology of the overwashed freshwater impoundment.

If the impoundments are still able to contain water (ie. the dikes, water control structures and/or surrounding dunes are not also damaged), then the overwashed pools should be drained as quickly as possible. Following draining, they should be immediately refilled with freshwater to the pre-storm level(s), from C-Storage Pool and/or the bay (using the pump station). Even if the bay has also been overwashed, it will probably be fresher than the oceanwater in the pool(s). The quicker this draining and refilling process is carried out, the less the negative impact upon the plant, fish and invertebrate communities within the overwashed pool(s).

Discussions have already been held between Refuge staff and the Zone Biologist, on how best to deal with a sudden influx of wintering migratory birds (principally waterfowl) that have been driven into this area by a severe freeze at their traditional wintering grounds further north. The concern was that the high-carbohydrate acorn food of live oaks, and the thermal cover provided by live oaks and waxmyrtle on the higher elevations of WMUs A, B, C, G, H and J, might not be available to a starving waterfowl influx when needed most.

Since such a freeze would usually occur during January or February, and since impoundment water levels are normally already being raised to the highest annual levels then, access to the high-carbohydrate acorn food of live oaks, is already being provided. These WMUs will also provide the best thermal

cover in cold winds. Therefore, the need for a separate "emergency program", of flooding the pools during a waterfowl influx from further north during bad freezes in January or February, is not necessary, since it has already occurred.

V. ADDITIONAL MANAGEMENT ACTIONS

A. Coordination with Other Agencies

The 4,600 acres of Back Bay Proclamation Waters have historically provided excellent migratory bird habitat. For the past fifteen years, however, the bay has shown a general decline in water quality, SAV's, and waterfowl populations. Land acquisition within the newly approved Back Bay NWR expansion boundary should result in a decrease in land development adjacent to Back Bay. Water quality improvements should begin to follow. However, to properly address changing times and new situations that will arise, it is critical that Refuge Staff continue coordinating with the local, state and federal agencies that regulate land and water changes. Otherwise, the progress that has been made during the past five years could be lost.

Because the Refuge does not own the water, most of the bay bottoms, nor much of the land around Back Bay, coordination with local government, civic organizations and individuals, and our local Ecological Services Office, is necessary to influence land use trends in this area.

The Refuge needs to coordinate with the Virginia Department of Game and Inland Fisheries (VDGIF) on matters concerning Back Bay. Boating impacts to waterfowl concentrations using the closed areas of the Refuge (Ragged Island and Bonney Cove/western Long Island) during the waterfowl hunting seasons in this area, are a matter of concern. Bonney and Ragged Island Coves currently provide some of the best waterfowl habitat, and support the largest numbers of waterfowl found on the waters of Back Bay. The impact to the Refuge waterfowl resource may be significant, if the birds are forced to burn significant energy reserves by being flushed out of the closed areas, and if they are forced to fly into the guns of the hunting public. Refuge records reveal that in 1960, then-Refuge Manager Yelverton recommended that a boating restriction in those areas be proposed to the State Game Department. The Regional Office (FWS) concurred. It is not known if negotiations on this issue were ever pursued. Whether boating impacts are significant to the health and well-being of the Refuge waterfowl population needs assessing by both the VDGIF and the Refuge, and a consensus reached.

Through zoning and development regulations, the government of the City of Virginia Beach can significantly influence the water quality and waterfowl habitats of Back Bay. Past City plans seem driven by short-term economic goals. The City plans to grow by 200,000 residents at "build-out"; many of these new residents will be in the Back Bay Watershed. A copy of the City of Virginia Beach's 1992 Comprehensive Plan is on file at the Refuge headquarters.

The City's "Green Line" concept is dead. The City now has plans to expand Ferrell Parkway and a large sewer line to Sandbridge. Improved public access and development potential for the entire Back Bay Watershed could follow. If the City follows through with their plans, the decline in Back Bay water quality and migratory bird habitat will be accelerated. The Refuge Manager must continue coordinating closely with the City of Virginia Beach on such matters concerning Back Bay and its watershed, if the water quality of this area, and the influence of Back Bay Refuge, are to continue improving.

Back Bay Refuge and the Fish & Wildlife Service should continue encouraging interagency cooperation on studies with the potential to identify problems affecting Back Bay and Currituck Sound. Such studies should be designed so that management recommendations are generated, and involved agencies assume management responsibilities.

VI. PROGRAM MANAGEMENT AND FUNDING NEEDS

During FY87, 88 and 89, additional equipment and supplies were procured to assist in the impoundment development effort. These included: a Ford 555B backhoe/loader, 1976 Allis-Chambers front-end loader, Kewanee disk, root-rake attachment for the JD 550A-LGP bulldozer, an airboat, and miscellaneous tools and equipment for habitat management.

However, many other needs exist to assist in the effective management of the fifteen Refuge Wetland Management Units. Table #5, below lists the most important needs:

TABLE #5 - Management & Funding Needs

<u>Item</u>	<u>Capital Cost</u>	<u>Annual Cost</u>
150 Drawbar HP 4x4 tractor with disk/cultipacker:	\$125,000	
Boat replacements (2) & trailers:	15,000	
Brush-hog mower:	6,000	
Terra-torch:	7,250	
Large-capacity, self-propelled Crisafulli pump:	25,000	
Replace hoses - Crisafulli pumps:	4,500	
RODEO purchases (minimum Phragmites control):		\$13,000
Maintain Dredged Channel to C-Storage Pool Pumps (rent a dredge for 3 mos. plus \$8,000 operating costs every 3 yrs.):		7,500
Contaminants testing - Back Bay (Back Bay Initiative electronic water monitors, testing through 1996):	100,000	25,000
Biological Technician (GS-7 salary, 0.5 FTE):		15,000
Biologist (GS-11 salary, 0.5 FTE):		18,500
Computer Needs:		
Programs for Recording Management Activities/Mapping:		
"Quick-Map"	- 500	
Digitizing Tablet	- 800	
G.I.S program, computer, printer & part-time Data Entry Specialist:	20,000	
Upgrade computer equipment, software & repairs:	4,000	1,000
Computer training:		1,000
Evaluation and inventories of managed units, and Inventory Plan revision:	1,000	1,000
GEMCO-ditching within pools (includes operator's salary):	3,000	
Ground-truth surveying of G-, H- & J-Pools' bottom elevations by FWS- Engineering (travel costs for two, for two weeks):	4,000	
Impoundment Management (WCS rip-rap, discing, root-raking, dike seeding, surveys, public use control, salaries, gates, fuel, etc.):		15,000
Manage impoundments fish populations (includes \$5,000/yr. funding for FAO, Gloucester, VA):	25,000	15,000*

<u>MARSH AND WATER</u>	<u>MANAGEMENT PLAN</u>	<u>BACK BAY NWR</u>
<u>Item</u>	<u>Capital Cost</u>	<u>Annual Cost</u>
FAO-Inventory fish populations in streams & ditches leading to Back Bay; obtain mgmt recommendations:	20,000	10,000*
Hydroaxe work - Habitat diversity restoration:	5,000	
Safety Equipment (aerial & boating surveys, fires, etc.)		2,500
Motor vehicle replacement (every six years):	20,000	
Refuge Marsh & Water Management educ'l brochure (one-time cost):	1,500	
Seasonal Biological Aid (GS-3) (surveys, transects, etc.):	8,900	
Install WCSs on newly acquired lands (moist soil mgt. & bay water quality improvements):		3,000
All terrain work vehicle (pest control, surveys, etc.):	12,000	
Construct ten portable crisafulli pump sites in pools:	2,500	
Purchase base biological supplies (invert. sampling equipment, soil corer, dissecting tools, etc.):		1,000
TOTALS	\$410,950	\$128,500
*(RECOMMENDED FIRST YEAR COSTS)		(Salaries = \$42,400)

Other Marsh and Water Management costs are included in the Refuge Fire Management, Wildlife Inventory and (interim) Animal Control Plans.

VII. Literature Cited

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APPENDIX A

ADDITIONAL TABLES

	Page Number
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TABLE #1 - VEGETATION TRANSECTS-1985 (IMPOUNDMENTS)

<u>Species</u>	<u>% of Total Species Present</u>		
	<u>Unit A</u>	<u>Unit B</u>	<u>Unit C</u>
<u>Bacopa monnieri</u>	14.0	22.7	18.3
<u>Juncus roemerianus</u>	32.0	2.0	21.7
<u>Spartina patens</u>	12.3	10.8	20.8
<u>Panicum virgatum</u>	4.2	22.2	0.8
<u>Eleocharis parvula</u>	7.2	0.8	20.0
<u>Lippia lanceolata</u>	3.0	8.0	5.8
<u>Cyperus haspan/polystachyos</u>	4.7	2.8	0.0
<u>Echinochloa crusgalli/walteri</u>	4.7	5.7	0.4
<u>Fimbristylus spadicea</u>	3.0	2.0	0.0
<u>Scirpus americana</u>	3.0	2.0	0.8
<u>Pluchea purpurascens</u>	2.1	1.7	0.0
<u>Centella asiatica</u>	0.4	0.0	6.7
<u>Distichlis spicata</u>	2.5	3.7	0.0
<u>Ruppia maritima</u>	0.0	5.7	0.0
<u>Typha angustifolia</u>	0.0	5.7	0.0
<u>Bidens cernua</u>	0.4	1.1	3.3
<u>Scirpus robustus</u>	1.3	0.0	0.0
<u>Eleocharis quadrangulata</u>	0.4	0.0	0.0
<u>Polygonum punctatum</u>	0.0	0.0	0.4
<u>Juncus effusus</u>	0.4	0.0	0.0
<u>Bare Ground</u>	5.1	2.8	2.0
% TOTALS	100.7	100.6	101.0

TABLE #2
BACK BAY NWR WETLAND MANAGEMENT UNIT HABITATS - 1960

POOL	TOTAL ACRES		TOTAL UPLAND		SWAMP WETLAND		EMERGENT WETLAND	
	A.	%	A.	%	A.	%	A.	%
A	221	- 100	40	- 18	15	- 7	166	- 75
B	114	- 100	2	- 2	3	- 3	109	- 96
C	240	- 100	34	- 14	---		206	- 86
D	17	- 100	13*	- 75	---		4*	- 25
E	25	- 100	10*	- 40	---		15*	- 60
TOTALS	617	- 100	99	- 16	18	- 3	500	- 81
(* estimated)								

TABLE #3
BACK BAY NWR WETLAND MANAGEMENT UNIT HABITATS - 1993

POOL	TOTAL ACRES		TOTAL UPLAND		WOODED SWAMP WETLAND		EMERGENT WETLAND	
	#	%	#	%	#	%	#	%
A	215	- 100	40	- 18	15	- 7	160	- 75
B	100	- 100	---		---		100	- 100
B-St.	13	- 100	2	- 15	3	- 23	8	- 62
C	190	- 100	34	- 14	---		156	- 86
C-St.	45	- 100	3	- 7	---		42	- 93
D	17	- 100	9	- 53	---		8	- 47
E	25	- 100	5	- 20	---		20	- 80
F	75	- 100	23*	- 30	---		52*	- 70
G	88	- 100	15*	- 17	---		73*	- 83
H	76	- 100	8*	- 10	2*	- 2	66	- 88
J	111	- 100	22*	- 20	33*	- 30	56	- 50
TOTALS	955	- 100	161	- 17	53	- 5	741	- 78
(* estimated)								

TABLE #4 - ENDANGERED/THREATENED & COMMON MIGRATORY BIRDSWinterers

tundra swan
black duck
mallard
canada goose
ylw-rpd warbler
snow goose
shoveler
pintail
widgeon
coot
great blue heron
western sandpiper
herring gull
gr. BB gull
ring-billed gull
northern harrier
red-tailed hawk
American kestrel
pied-billed grebe
gannet
common loon

Winterers

least bittern
Cooper's hawk
merlin
snow egret
great egret
cattle egret
great blue heron
green-backed heron
little blue heron
tricolored heron
black-cr.night heron
ylw.-cr.night heron
glossy ibis
white ibis
sanderling
common snipe
American woodcock
killdeer
semipalmated plover
black-bellied plover
willet
ruddy turnstone
dunlin
whimbrel
semipalmated sandpiper
western sandpiper
spotted sandpiper
double-cr. cormorant
brown pelican
gannet
red-br. merganser
American merganser
hooded merganser
white-winged scoter
surf scoter
bufflehead
Neotropicals

Nesters

wood duck
black duck
mallard
canada goose
ylw-rpd warbler
B/W teal
kestrel
osprey
Virginia rail
clapper rail
king rail
barn owl
screech owl
barred owl
Red-shldrd hawk
American kestrel
Neotropicals
American bittern
purple martin
barn swallow
tree swallow
eastern bluebird

Migrants

piping plover(threatened)
bald eagle (endangered)
peregrine falcon
(endangered)
G/W teal
B/W teal
shoveler
common tern
royal tern
Caspian tern
least tern
sandwich tern
Forster's tern
gull-billed tern
American bittern
l.b. dowitcher
s.b. dowitcher
Gr. yellowlegs
L. yellowlegs
Northern harrier
sharp-shinned hawk
red-tailed hawk
American kestrel

Table #5 Foraging guilds of shorebirds in North America

Shorebird Group	Common Name	Scientific Name	Foraging Guild
Plover	Black-bellied Plover	<i>Pluvialis squatarola</i>	terrestrial/aquatic gleaner
	Lesser Golden Plover	<i>Pluvialis dominica</i>	
	Snowy Plover	<i>Charadrius alexandrinus</i>	
	Wilson's Plover	<i>Charadrius wilsonia</i>	
	Semipalmated Plover	<i>Charadrius semipalmatus</i>	
	Piping Plover	<i>Charadrius melodus</i>	
	Killdeer	<i>Charadrius vociferus</i>	
	Mountain Plover	<i>Charadrius montanus</i>	
Curlew	Eskimo Curlew	<i>Numenius borealis</i>	terrestrial/aquatic gleaner/prober
	Whimbrel	<i>Numenius phaeopus</i>	
	Long-billed Curlew	<i>Numenius americanus</i>	
Small Sandpiper	Sanderling	<i>Calidris alba</i>	aquatic prober/gleaner
	Semipalmated Sandpiper	<i>Calidris pusilla</i>	
	Western Sandpiper	<i>Calidris mauri</i>	
	Least Sandpiper	<i>Calidris minutilla</i>	
	White-rumped Sandpiper	<i>Calidris fuscicollis</i>	
	Baird's Sandpiper	<i>Calidris bairdii</i>	
Medium Sandpiper	Red Knot	<i>Calidris cantus</i>	aquatic prober/gleaner
	Pectoral Sandpiper	<i>Calidris melanotos</i>	
	Stilt Sandpiper	<i>Calidris himantopus</i>	
	Dunlin	<i>Calidris alpina</i>	
	Short-billed Dowitcher	<i>Limondromus griseus</i>	
	Long-billed Dowitcher	<i>Limondromus scolopaceus</i>	
	Common Snipe	<i>Gallinago gallinago</i>	
	Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>	
	Upland Sandpiper	<i>Bartramia longicauda</i>	aquatic/terrestrial gleaner
Godwit	Hudsonian Godwit	<i>Limosa haemastica</i>	aquatic prober
	Marbled Godwit	<i>Limosa fedoa</i>	
Yellowlegs	Greater Yellowlegs	<i>Tringa melanoleuca</i>	aquatic gleaner
	Lesser Yellowlegs	<i>Tringa flavipes</i>	
	Solitary Sandpiper	<i>Tringa solitaria</i>	
	Willet	<i>Catoptrophorus semipalmatus</i>	
Turnstone	Ruddy Turnstone	<i>Arenaria interpres</i>	terrestrial/aquatic gleaner/prober
	Black Turnstone	<i>Arenaria melanocephala</i>	
	Surfbird	<i>Aphriza virgata</i>	
	Wandering Tattler	<i>Heteroscelus incanus</i>	
	Spotted Sandpiper	<i>Actites macularia</i>	
	Purple Sandpiper	<i>Calidris maritima</i>	
	Rock Sandpiper	<i>Calidris ptilocnemis</i>	
Avocet/Stilt	Black-necked Stilt	<i>Himantopus himantopus</i>	aquatic gleaner/sweeper
	American Avocet	<i>Recurvirostra americana</i>	
Phalarope	Wilson's Phalarope	<i>Phalaropus tricolor</i>	aquatic/pelagic gleaner
	Northern Phalarope	<i>Phalaropus lobatus</i>	
	Red Phalarope	<i>Phalaropus fulicarius</i>	
Oystercatcher	American Oystercatcher	<i>Haematopus palliatus</i>	aquatic prober/prier
	Black Oystercatcher	<i>Haematopus bachmani</i>	

(FROM HELMERS, 1992)

Table 6. *Habitat conditions that attract vertebra*

Vertebrate group	Foods				Water depth	Habitat cover		
	Vertebrates	Invertebrates	Seeds	Browse		t	Dense	Sparse
Amphibians		✓			0-			✓
Reptiles	✓	✓			0-		✓	✓
Grebes	✓				25			✓
Geese			✓	✓	0-		✓	✓
Dabbling ducks		✓	✓		5-1			
Diving ducks		✓	✓		25 -			
Hawks	✓				NA	✓	✓	✓
Galliforms		✓	✓		D-M	✓	✓	✓
Hérons	✓	✓			7-12	✓	✓	✓
Rails		✓	✓		5-30	✓	✓	
Coots			✓	✓	28-33	✓	✓	✓
Shorebirds		✓			0-7	✓	✓	✓
Owls	✓				D-M	✓	✓	✓
Swallows		✓			NA	✓	✓	✓
Sedge wrens		✓			NA	✓	✓	✓
Nesting passerines		✓	✓		NA	✓	✓	✓
Winter fringillids			✓		NA	✓	✓	✓
Rabbit				✓	0	✓	✓	
Raccoon	✓	✓	✓		0-10	✓	✓	✓
Deer				✓	0	✓		

^aD-M = dry to moist; NA = not applicable (use of units is not dependent on flooding or specific water depths).

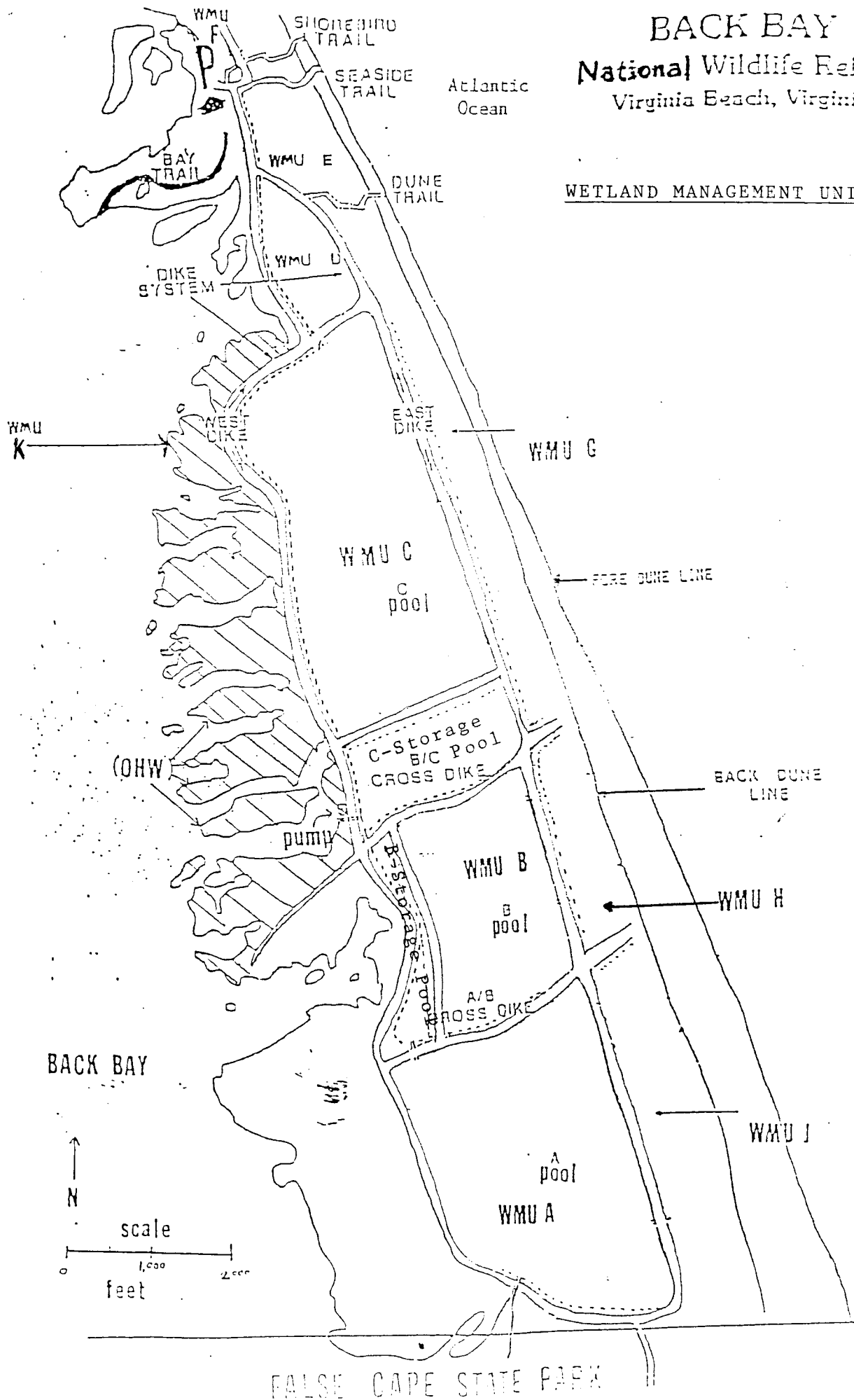
APPENDIX B1

WMU WATER CONTROL STRUCTURE REFERENCE

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Wetland Management Units A-J.....	85
Wetland Management Unit A.....	86
Wetland Management Unit B.....	87
Wetland Management Unit C.....	88
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Wetland Management Unit K.....	94
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Wetland Management Unit M.....	96
Wetland Management Unit N.....	97

BACK BAY National Wildlife Refuge Virginia Beach, Virginia

WETLAND MANAGEMENT UNITS A - J



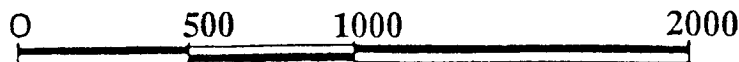
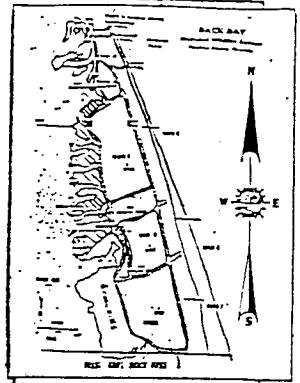
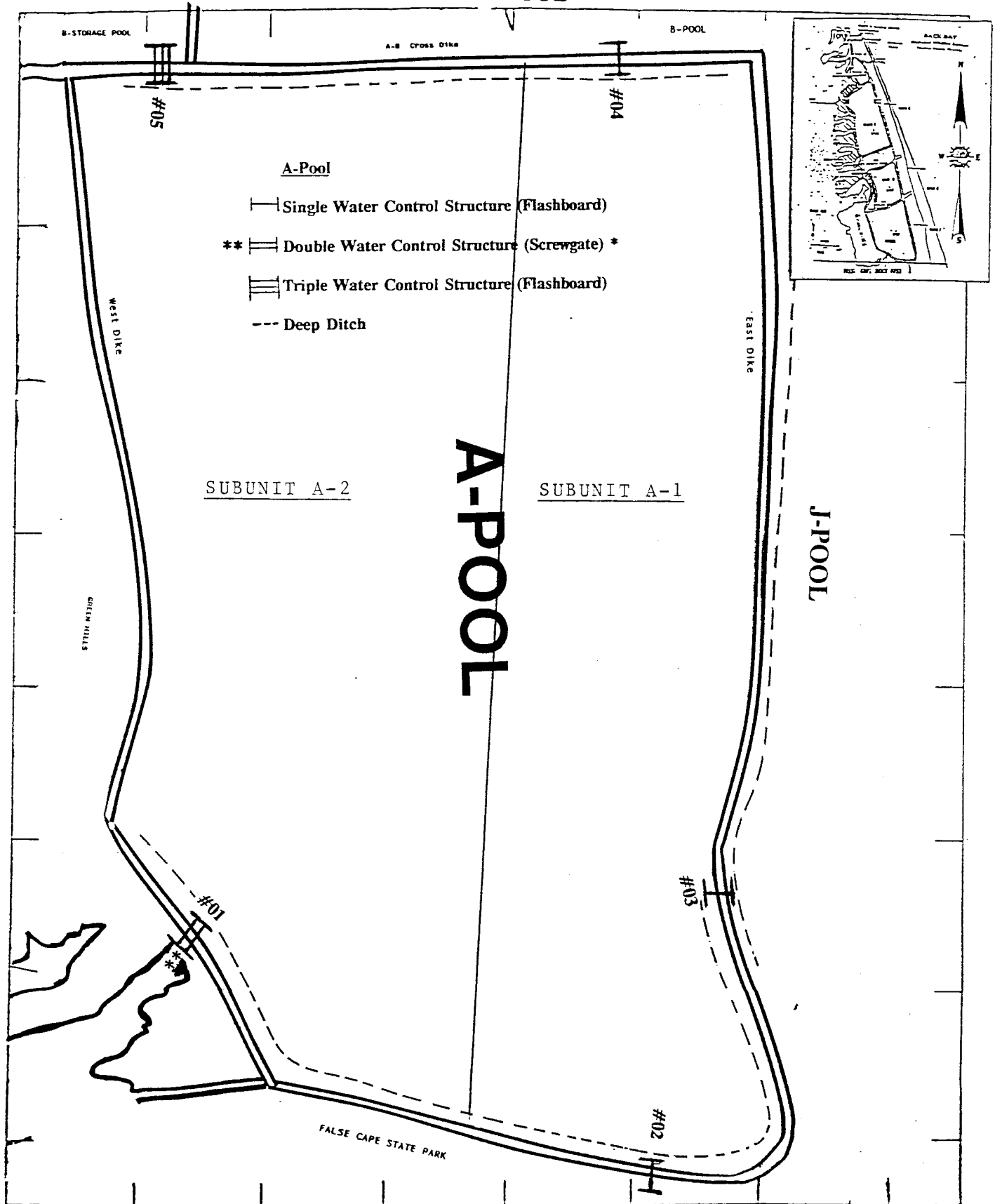
BACK BAY NATIONAL WILDLIFE REFUGE

CITY OF VIRGINIA BEACH, VIRGINIA

UNITED STATES
DEPARTMENT OF THE INTERIOR

UNITED STATES
FISH AND WILDLIFE SERVICE

A-POOL



Scale in Feet

Scale 1 in. = 500 ft.

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CITY OF VIRGINIA BEACH, VIRGINIA

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DEPARTMENT OF THE INTERIOR

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FISH AND WILDLIFE SERVICE

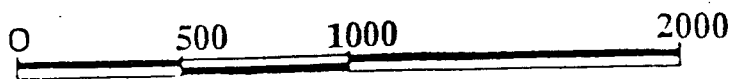
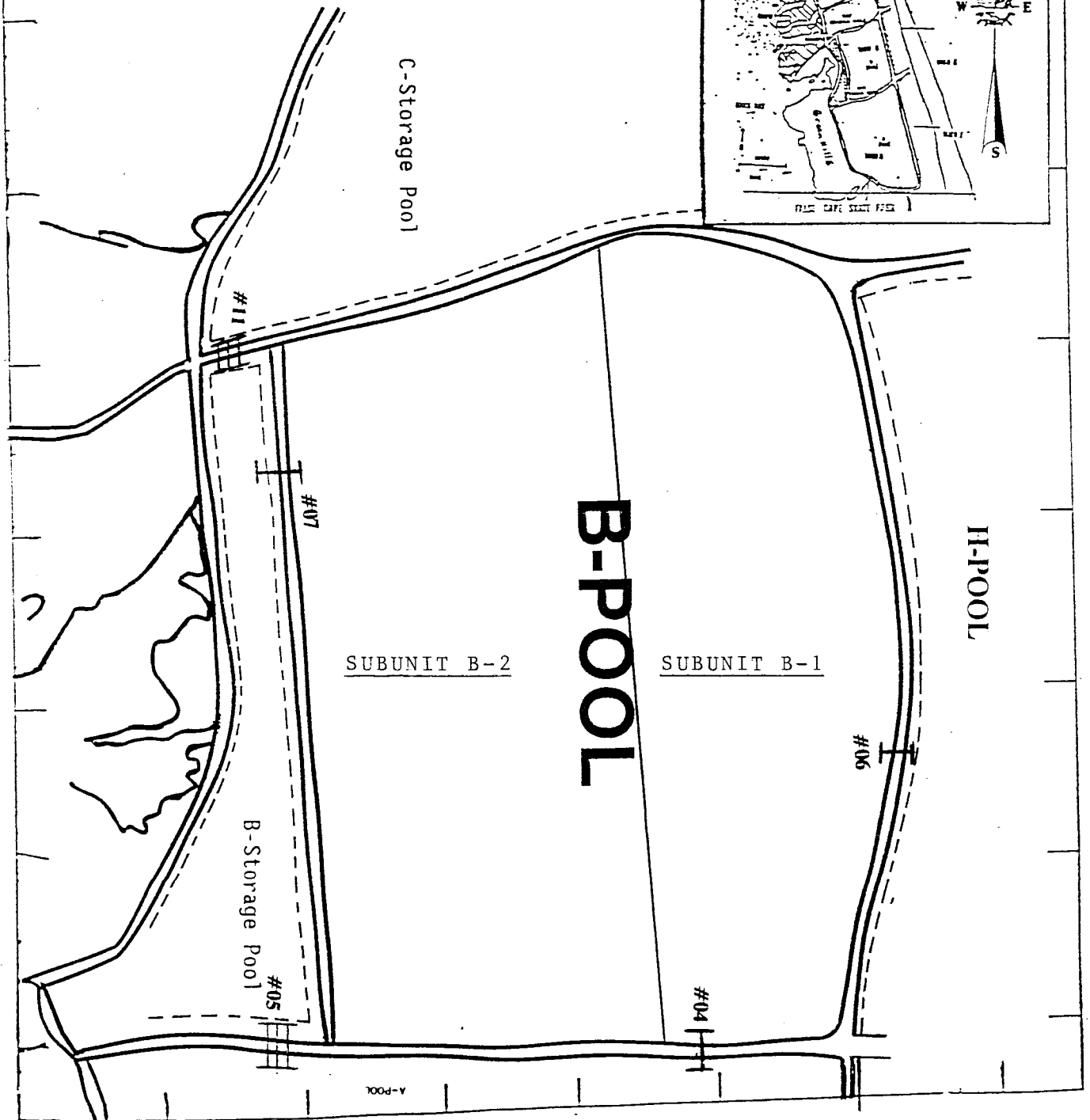
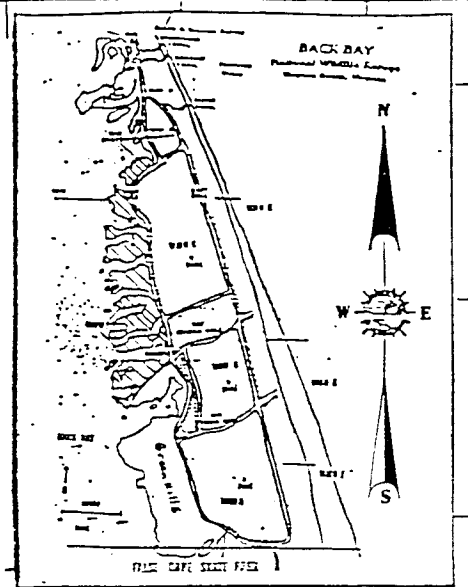
B-POOL

B-Pool and B-storage Pool

—|— Single Water Control Structure (Flashboard)

≡≡≡ Triple Water Control Structure (Flashboard)

--- Deep Ditch



Scale 1 in. = 500 ft.

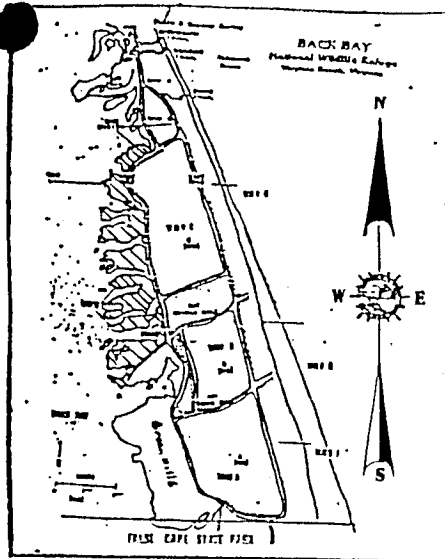
BACK BAY NATIONAL WILDLIFE REFUGE

CITY OF VIRGINIA BEACH, VIRGINIA

C-POOL

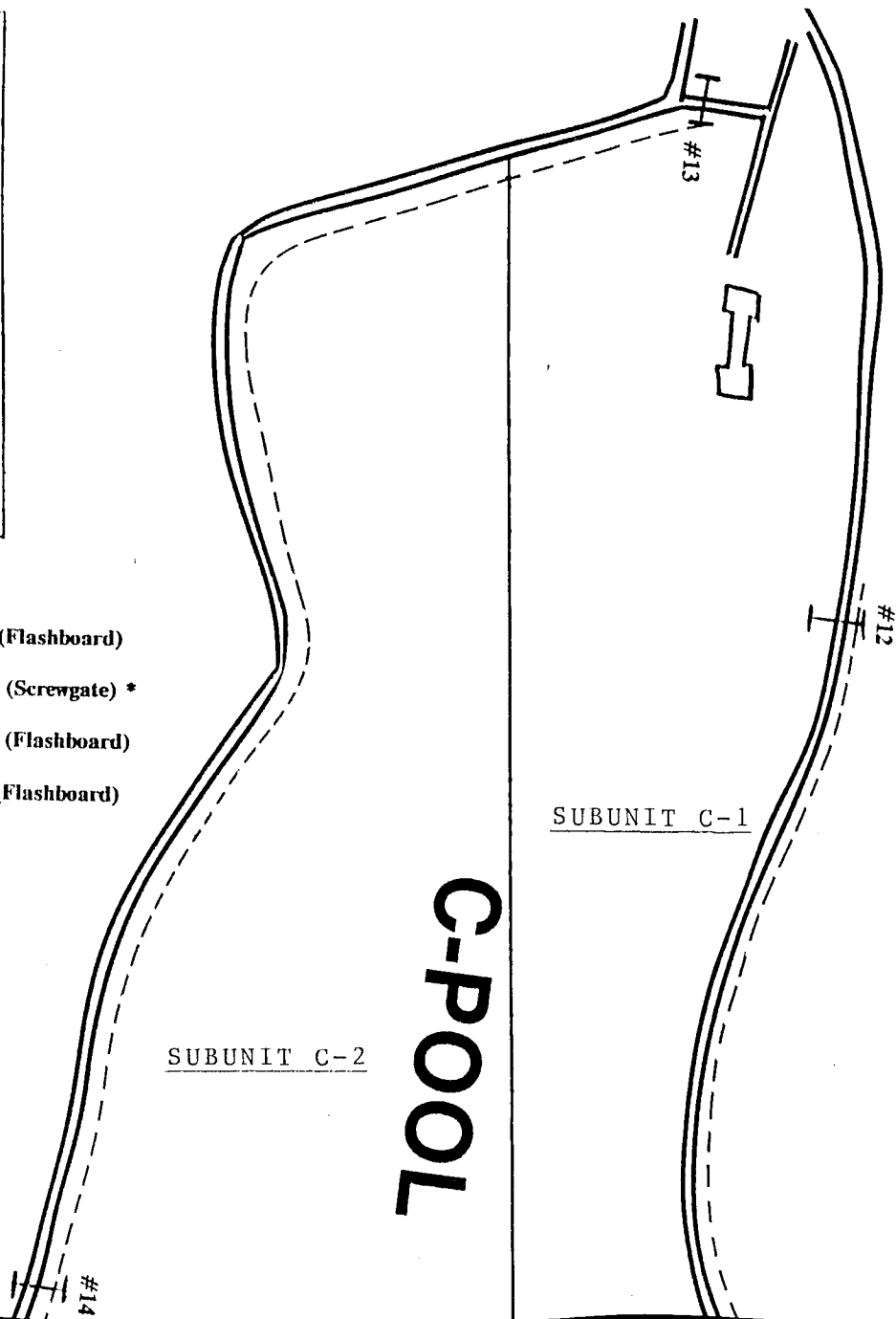
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UNITED STATES
FISH AND WILDLIFE SERVICE



C-Pool and C-storage pool

- |— Single Water Control Structure (Flashboard)
- ** —|— Double Water Control Structure (Screwgate) *
- |— Double Water Control Structure (Flashboard)
- |— Triple Water Control Structure (Flashboard)
- // Pumps **
- Deep Ditch

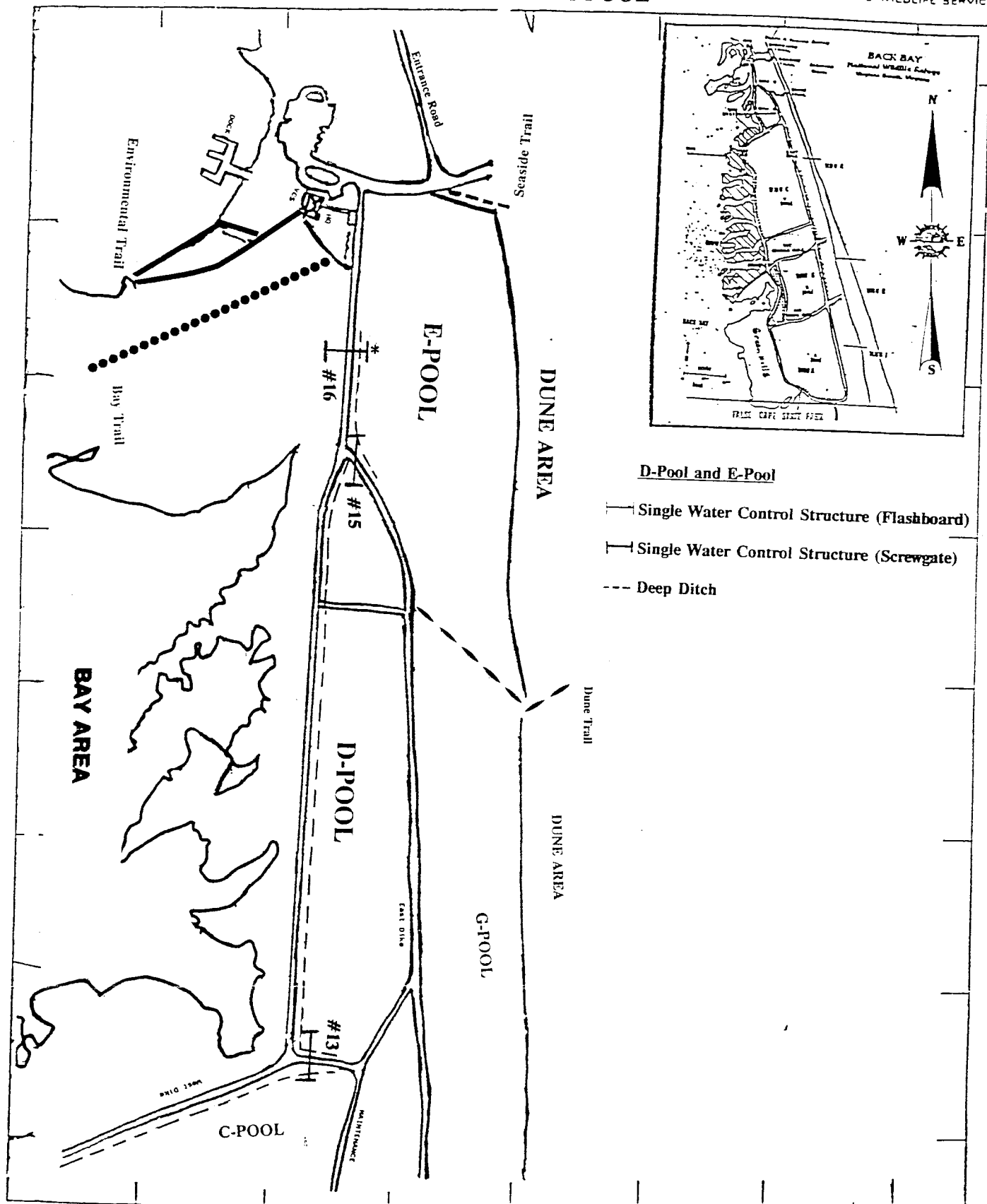


CITY OF VIRGINIA BEACH, VIRGINIA

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D-POOL and E-POOL



Scale 1 in. = 500 ft.

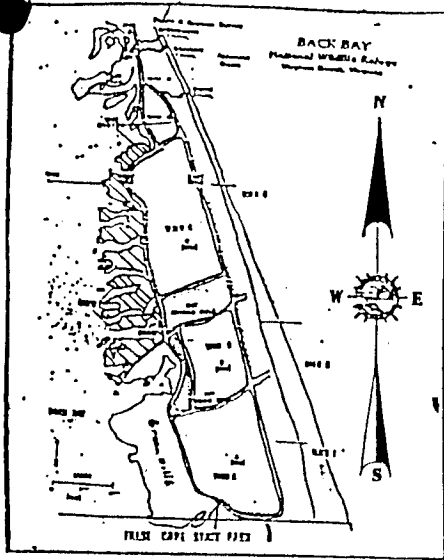
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BACK BAY NATIONAL WILDLIFE REFUGE
CITY OF VIRGINIA BEACH, VIRGINIA

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DEPARTMENT OF THE INTERIOR

WMU F

UNITED STATES
FISH AND WILDLIFE SERVICE



Wetland Management Unit F

--- Deep Ditch

SAND B

Wetland Management Unit F

DUNE AREA

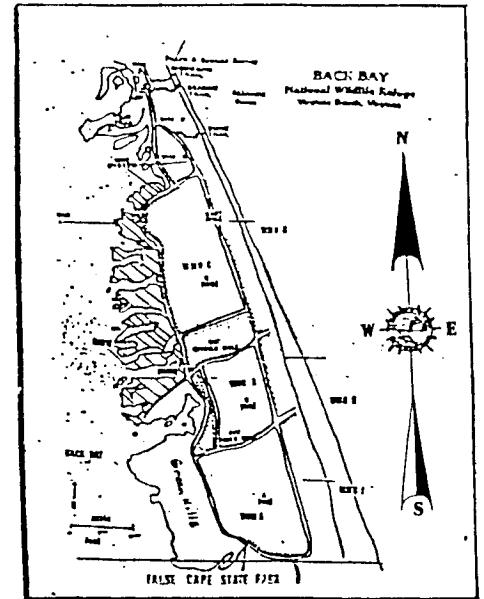
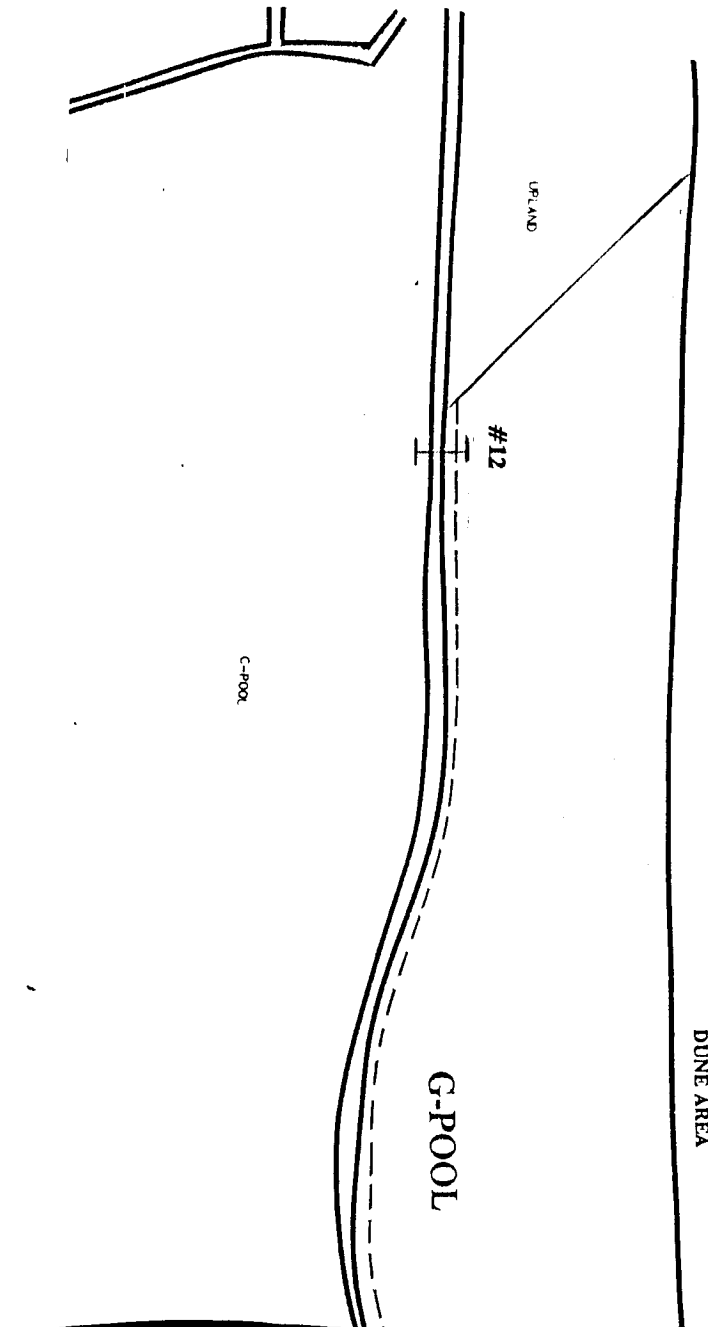
BACK BAY NATIONAL WILDLIFE REFUGE

CITY OF VIRGINIA BEACH, VIRGINIA

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G-POOL



G-POOL

- |— Single Water Control Structure (Flashboard)
- ==|== Double Water Control Structure (Flashboard)
- Deep Ditch

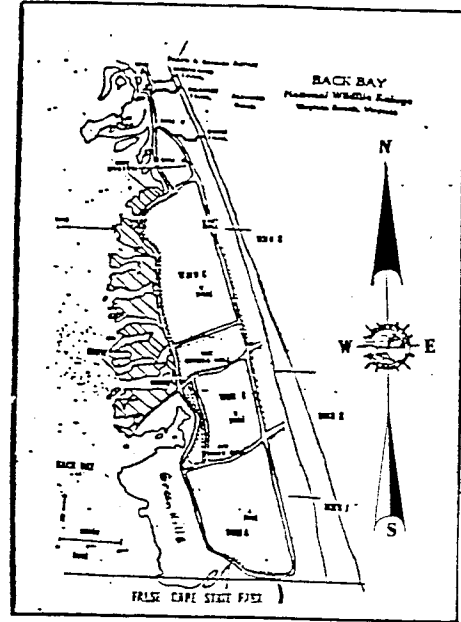
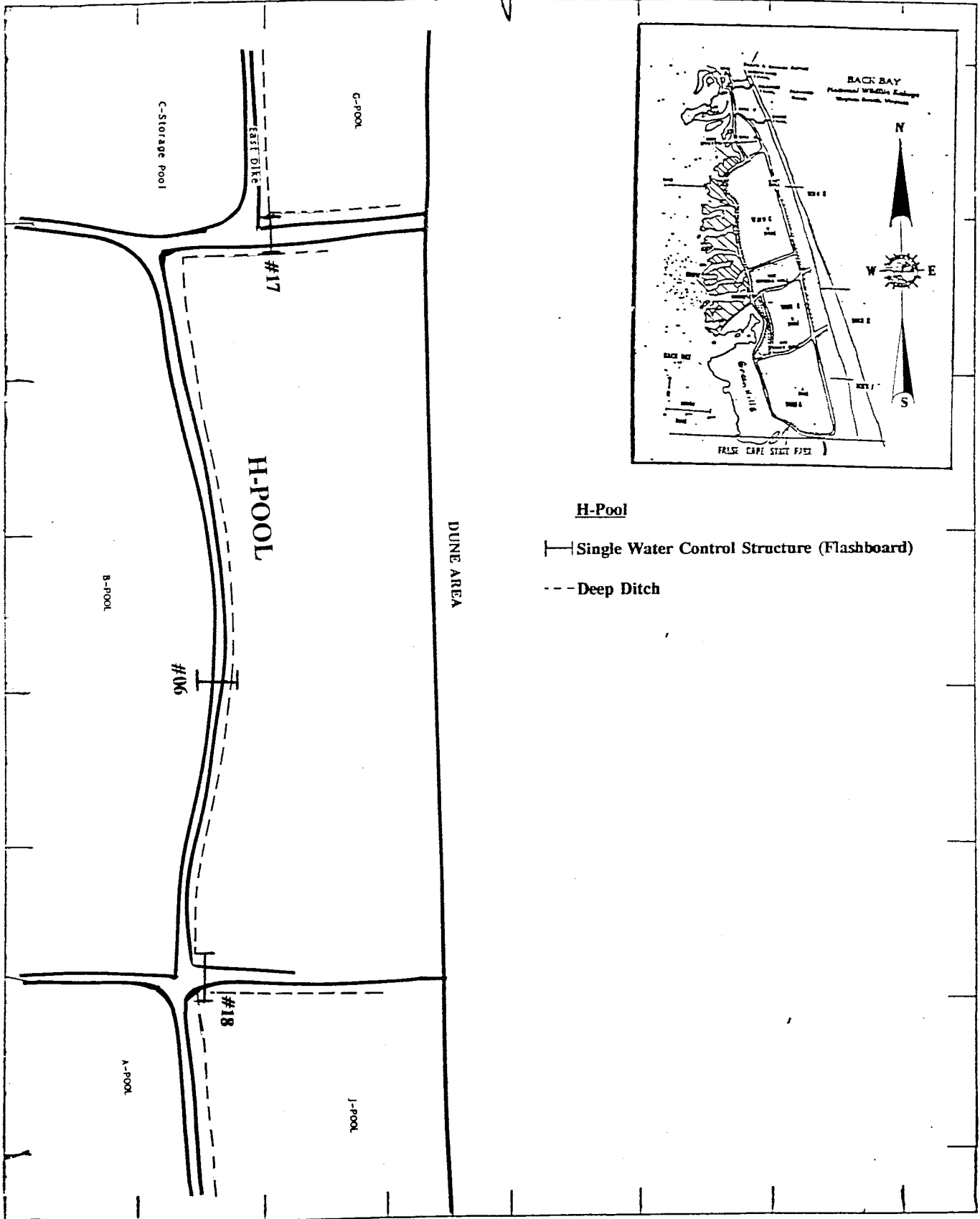
BACK BAY NATIONAL WILDLIFE REFUGE

CITY OF VIRGINIA BEACH, VIRGINIA

UNITED STATES
DEPARTMENT OF THE INTERIOR

H-POOL

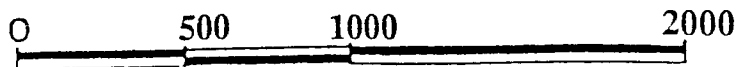
UNITED STATES
FISH AND WILDLIFE SERVICE



H-POOL

—|— Single Water Control Structure (Flashboard)

--- Deep Ditch



Scale in Feet

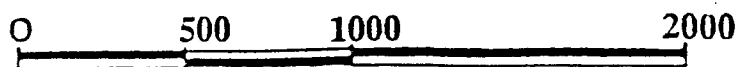
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CITY OF VIRGINIA BEACH, VIRGINIA

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DEPARTMENT OF THE INTERIOR

UNITED STATES
FISH AND WILDLIFE SERVICE

J-POOL



Scale in Feet

Scale 1 in. = 500 ft.

BACK BAY NATIONAL WILDLIFE REFUGE

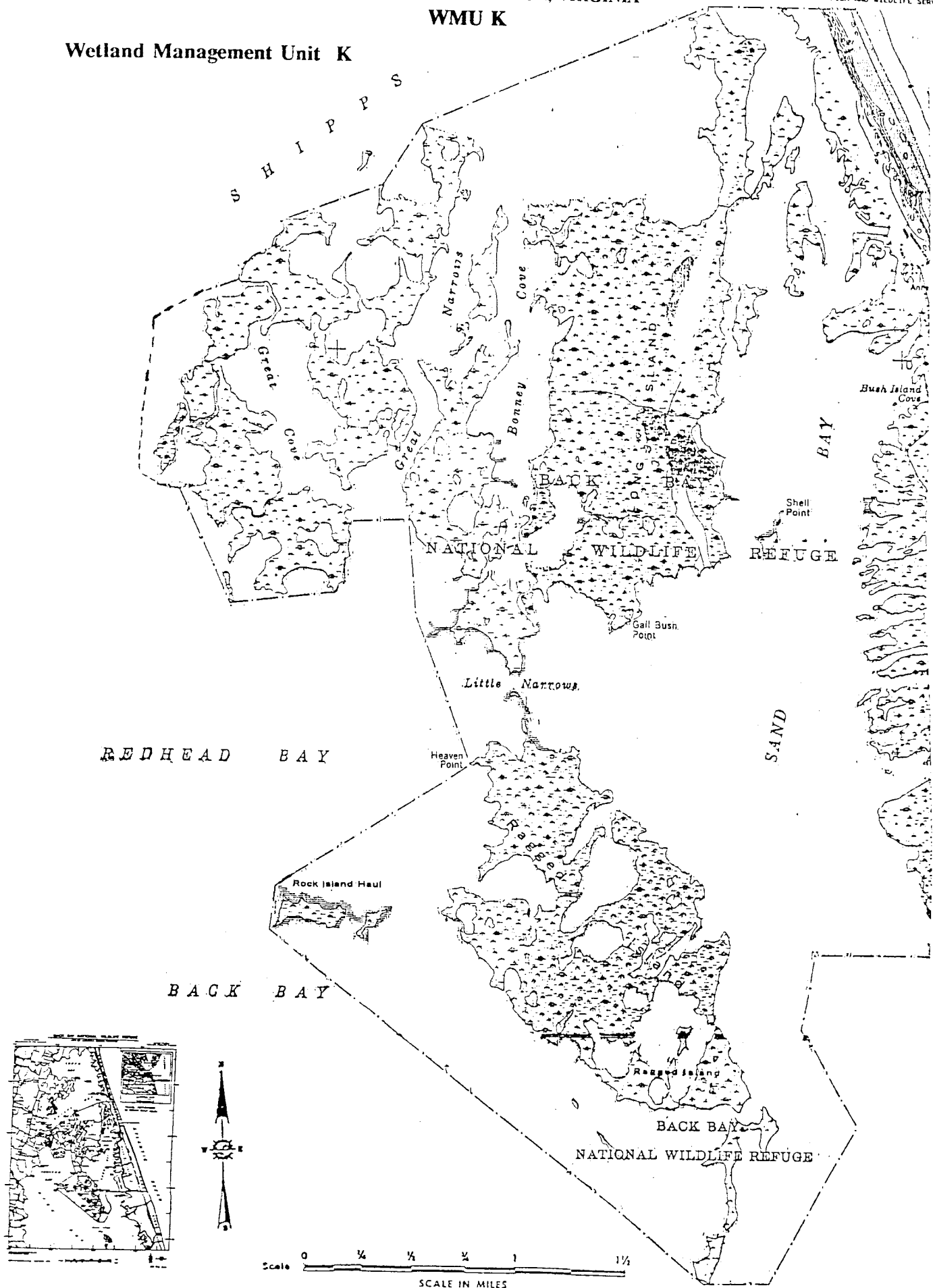
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DEPARTMENT OF THE INTERIOR

CITY OF VIRGINIA BEACH, VIRGINIA

UNITED STATES
FISH AND WILDLIFE SERVICE

WMU K

Wetland Management Unit K



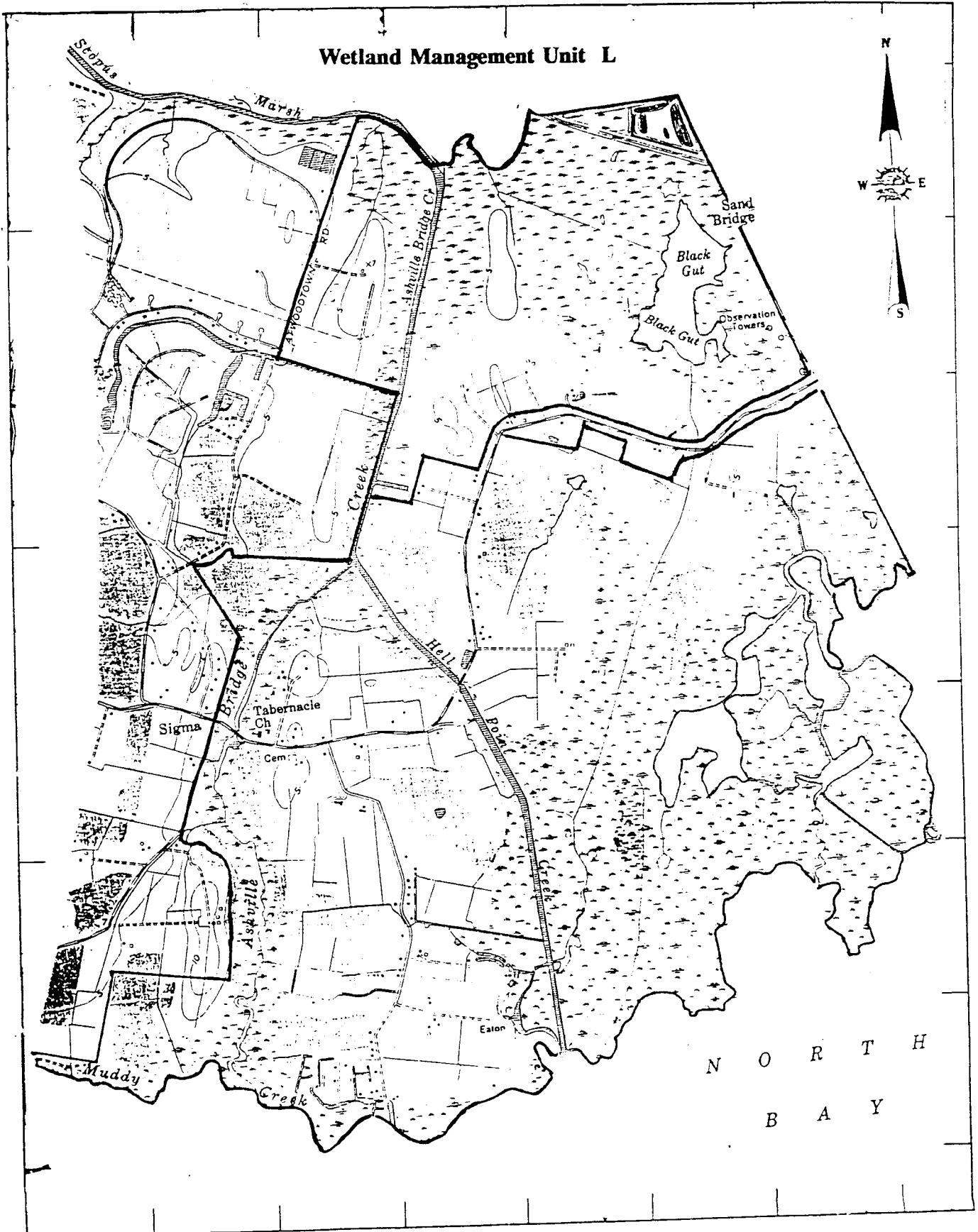
BACK BAY NATIONAL WILDLIFE REFUGE

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WMU L

UNITED STATES
FISH AND WILDLIFE SERVICE



BACK BAY NATIONAL WILDLIFE REFUGE

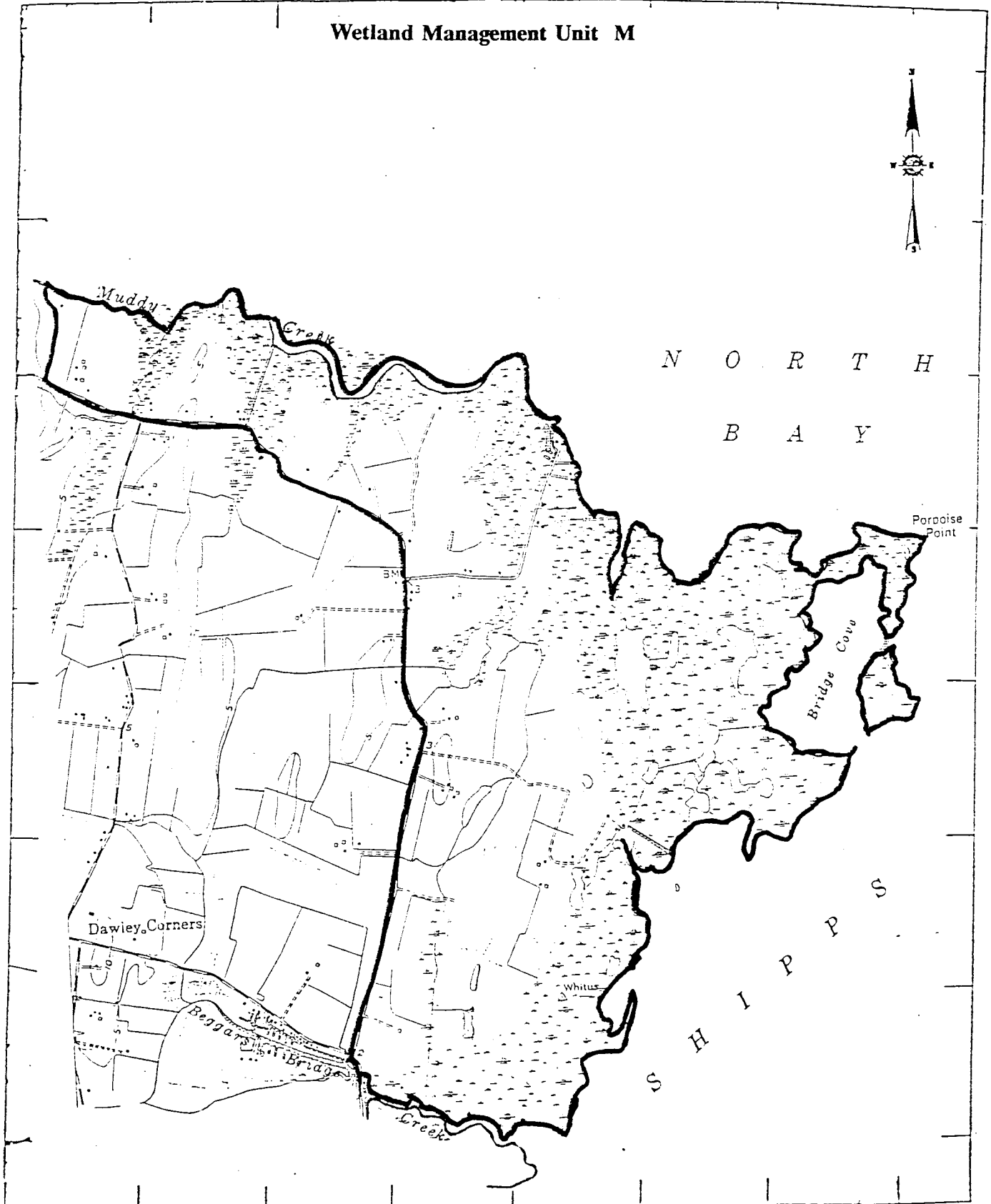
CITY OF VIRGINIA BEACH, VIRGINIA

WMU M

UNITED STATES
DEPARTMENT OF THE INTERIOR

UNITED STATES
FISH AND WILDLIFE SERVICE

Wetland Management Unit M



Scale 0 1/4 1/2 3/4 1 1 1/4
SCALE IN MILES

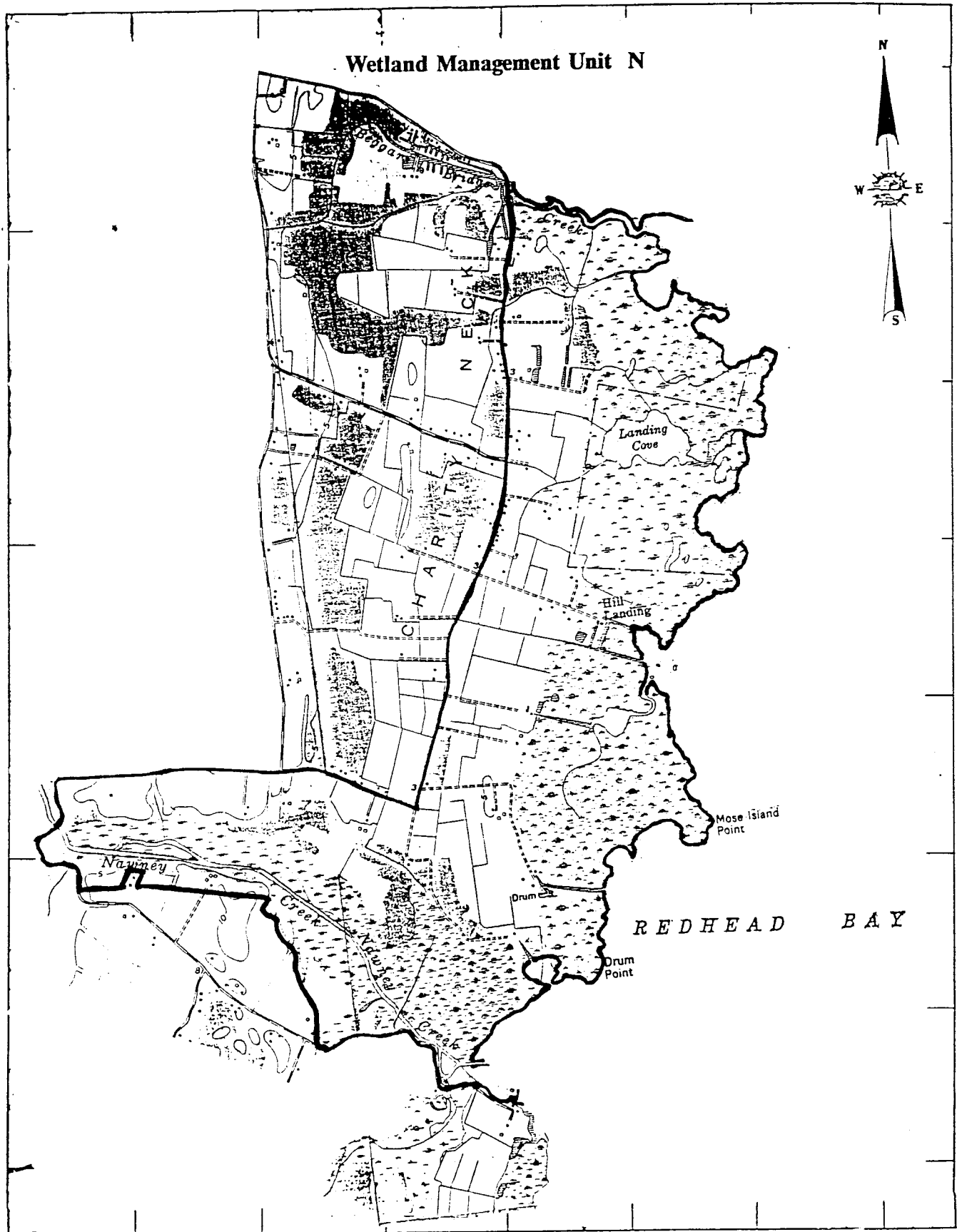
BACK BAY NATIONAL WILDLIFE REFUGE

CITY OF VIRGINIA BEACH, VIRGINIA

UNITED STATES
DEPARTMENT OF THE INTERIOR

UNITED STATES
FISH AND WILDLIFE SERVICE

WMU N

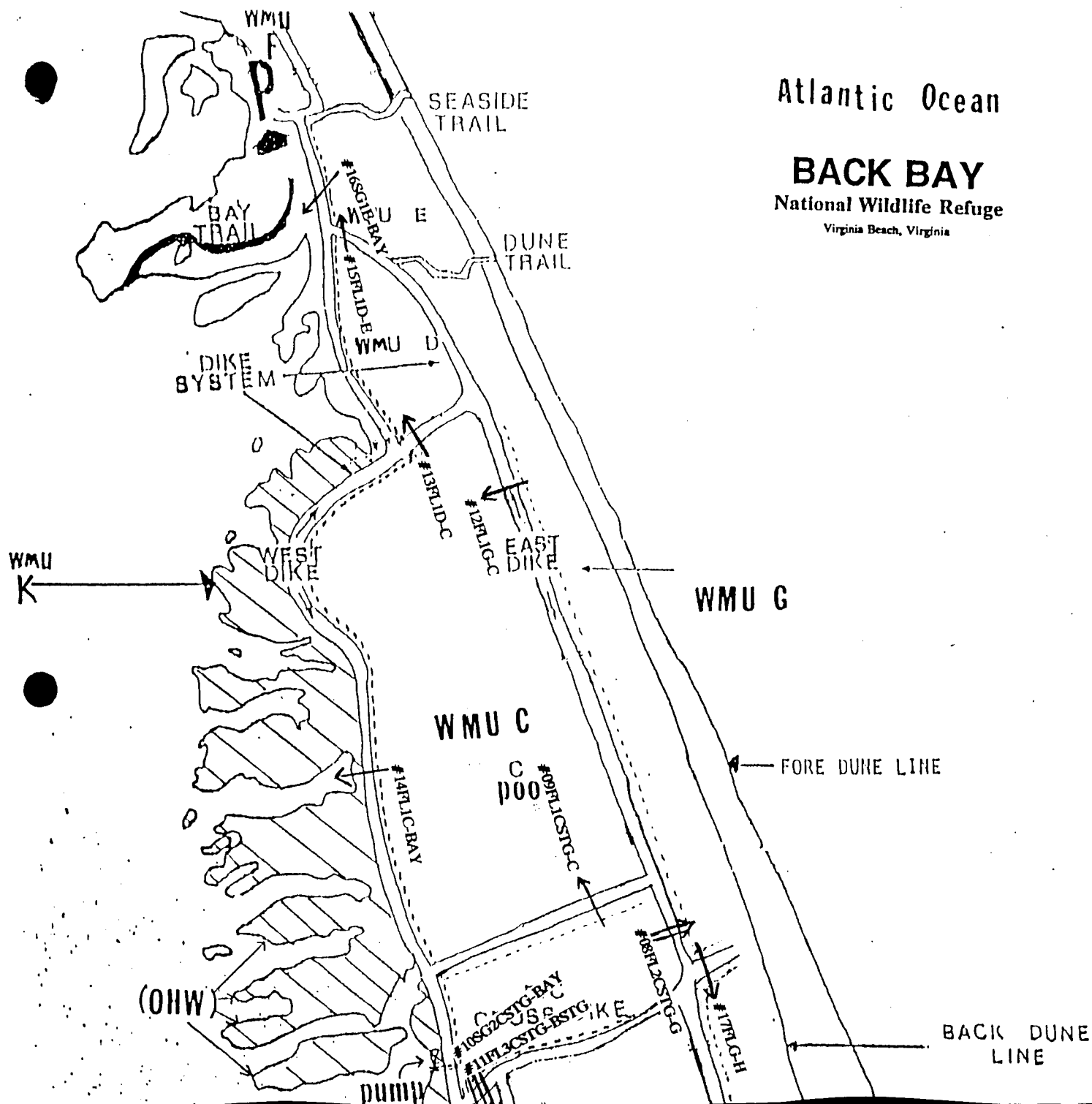


APPENDIX B2

WMU WATER CONTROL STRUCTURE REFERENCE

	Page Number
Water Control Structure Map.....	99
Water Control Structure Reference/List.....	100-101

National Wildlife Refuge
Virginia Beach, Virginia



WATER CONTROL STRUCTURE REFERENCE**CODES USED:**

SG = Screwgate Water Control Structure
FL = Flashboard Water Control Structure

Example: 01 SG 2 A - Bay

01 = Structure number

SG = Screwgate Water Control Structure

2 = Two tubes in structure

A-Bay = Usual Water Flow From A-Pool to Bay.

Water Control Structure List**A-Pool**

01SG2A-BAY.....Screwgate, 2 tubes, A-pool into Bay.
02FL1A-FCSP.....Flashboard, 1 tube, A-Pool into False
Cape State Park impoundment.
03FL1J-A.....Flashboard, 1 tube, J-Pool into A-Pool.
04FL1B-A.....Flashboard, 1 tube, B-Pool into A-Pool.
05FL3BSTG-A.....Flashboard, 3 tubes, B-Storage into A-Pool.

B-Pool

06FL1H-B.....Flashboard, 1 tube, H-pool into B-pool
07FL1BSTG-B.....Flashboard, 1 tube, B-Storage into B-pool.

C-Storage Pool

08FL2CSTG-G.....Flashboard, 2 tubes, C-storage into G-Pool.
09FL1CSTG-C.....Flashboard, 1 tube, C-storage into C-Pool.
10SG2CSTG-BAY.....Screwgate, 2 tubes, C-storage into Bay.
11FL3CSTG-BSTG.....Flashboard, 3 tubes, C-Storage into B-Storage.

C-Pool

12FL1G-C.....Flashboard, 1 tube, G-pool into C-Pool.

13FL1D-C.....Flashboard, 1 tube, D-pool into C-pool.

14FL1C-BAY.....Flashboard, 1 tube, C-Pool into Bay.

D-Pool and E-Pool

15FL1D-E.....Flashboard, 1 tube, D-Pool into E-Pool.

16SG1E-BAY.....Screwgate, 1 tube, E-Pool into Bay.

G-Pool, H-Pool, and J-Pool

17FLG-H.....Flashboard, 1 tube, G-Pool into Bay.

18FLH-J.....Flashboard, 1 tube, H-Pool into J-Pool.



APPENDIX B3

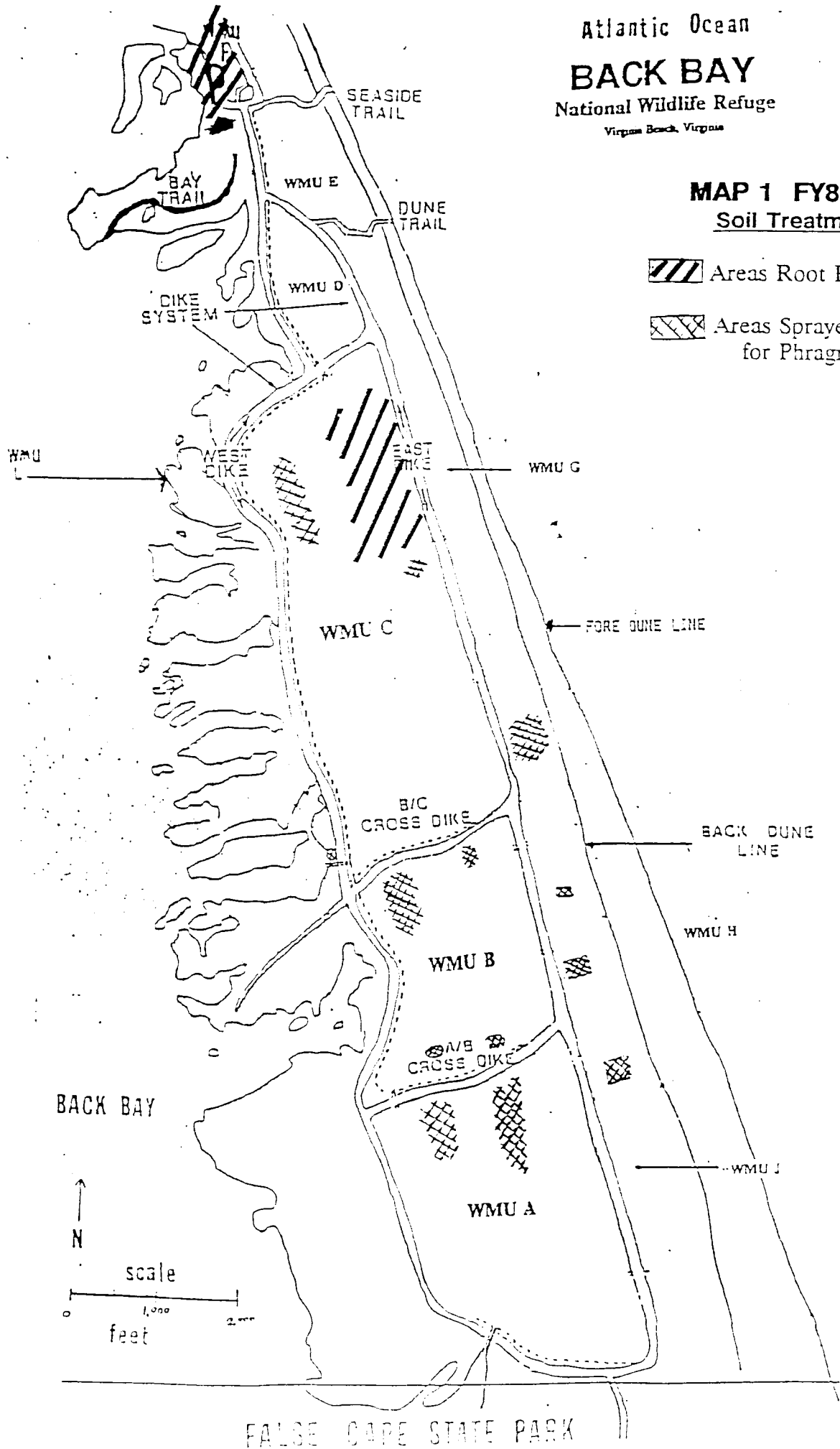
1986-1993 WMU SOIL TREATMENTS

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Atlantic Ocean
BACK BAY
 National Wildlife Refuge
 Virginia Beach, Virginia


MAP 1 FY86-87
Soil Treatment

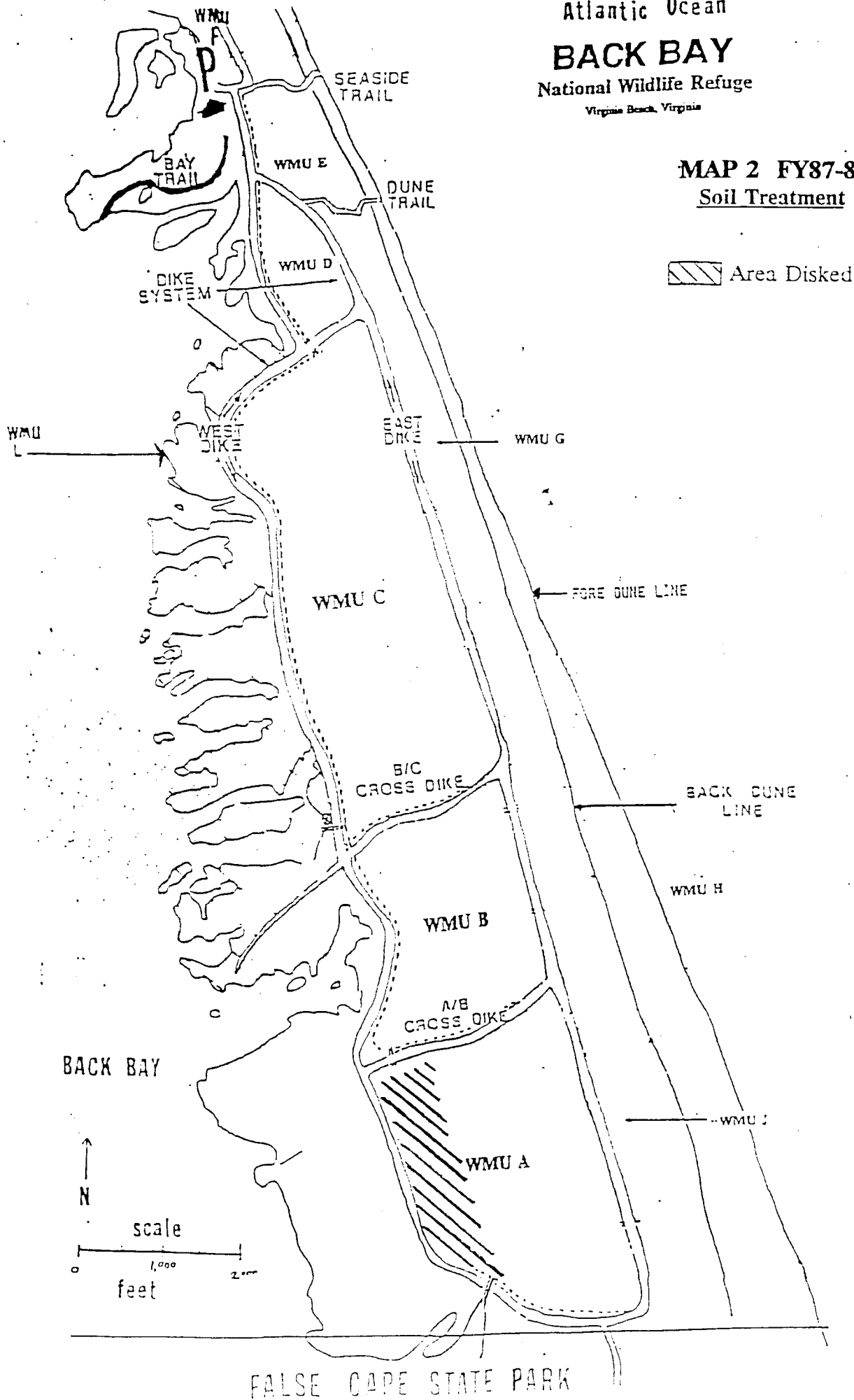
-  Areas Root Raked
-  Areas Sprayed for Phragmites



Atlantic Ocean
BACK BAY
National Wildlife Refuge
Virginia Beach, Virginia

MAP 2 FY87-88
Soil Treatment



 Area Disked

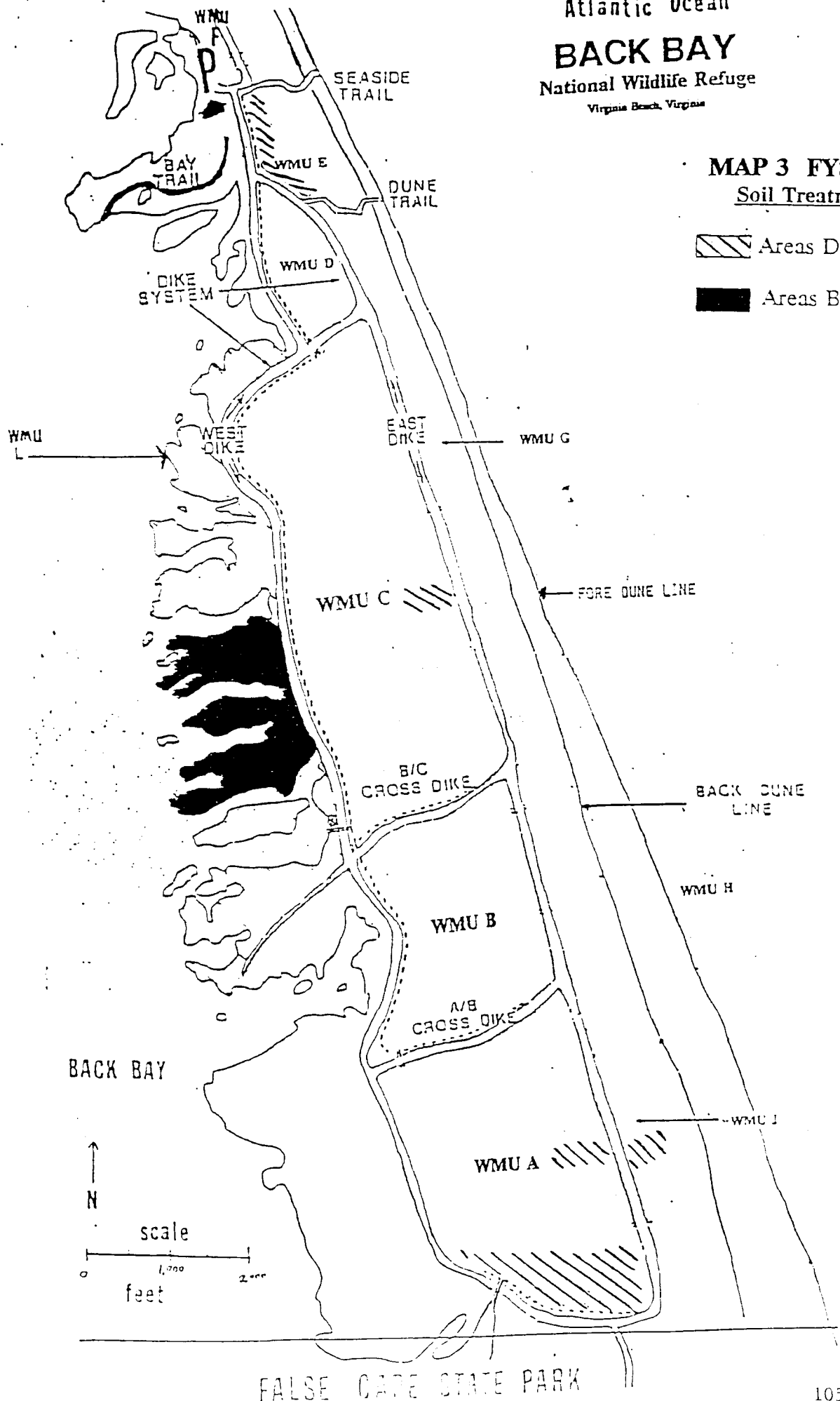


Atlantic Ocean
BACK BAY
National Wildlife Refuge
Virginia Beach, Virginia

MAP 3 FY88-89

Soil Treatment




-  Areas Disked
 Areas Burned

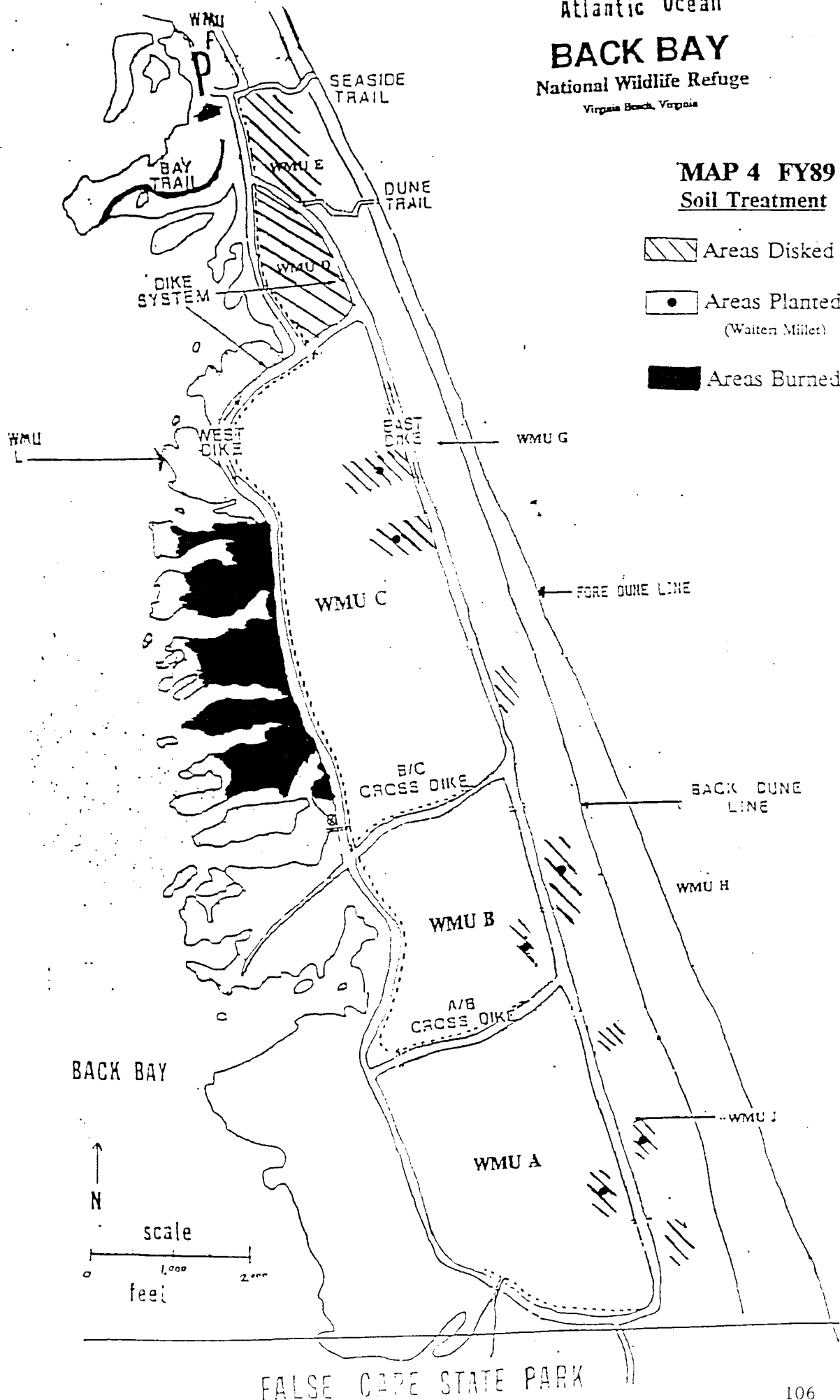


FALSE CAPE STATE PARK

Atlantic Ocean
BACK BAY
 National Wildlife Refuge
 Virginia Beach, Virginia

MAP 4 FY89
Soil Treatment

-  Areas Disked
-  Areas Planted
(Walter Miller)
-  Areas Burned



MAP 4a FY89
Soil Treatment

Areas Burned

Overnight Parking
For State Park

BACK BAY
National Wildlife Refuge
Virginia Beach, Virginia

Bush Island Cove

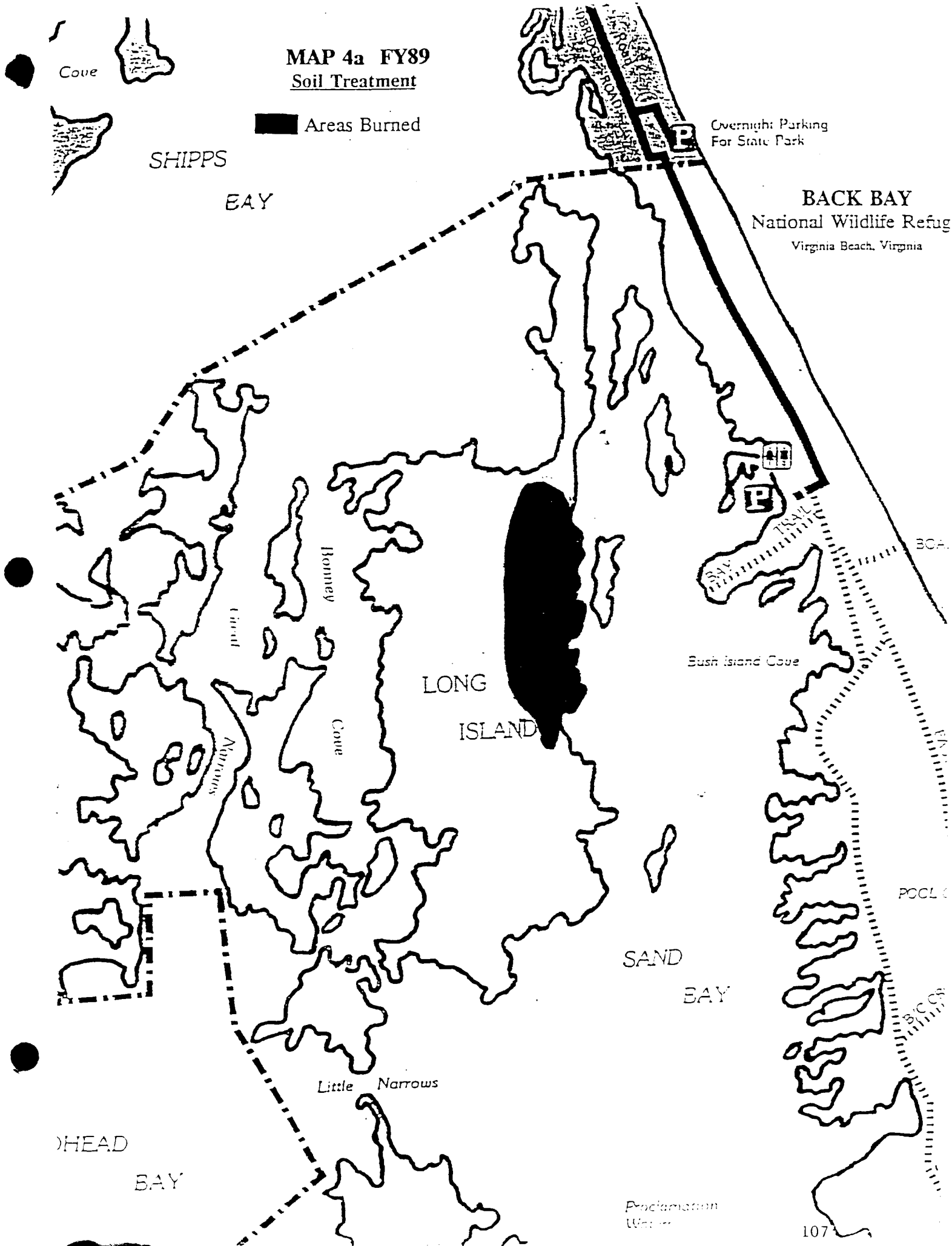
LONG
ISLAND

SAND
BAY

Little Narrows

HEAD
BAY

Proclamation
Water



MAP 4b FY89
Soil Treatment



Areas Disked
and Planted
(Winter Wheat)

Overnight Parking
For State Park

BACK BAY
National Wildlife Ref
Virginia Beach, Virginia

Bush Island Cove

POOL

BICC

SAND
EAY

Little Narrows

Proclamation
Waters



SHIPPS

EAY

LONG

ISLAND

Bonney

Cove

Good


Narrows

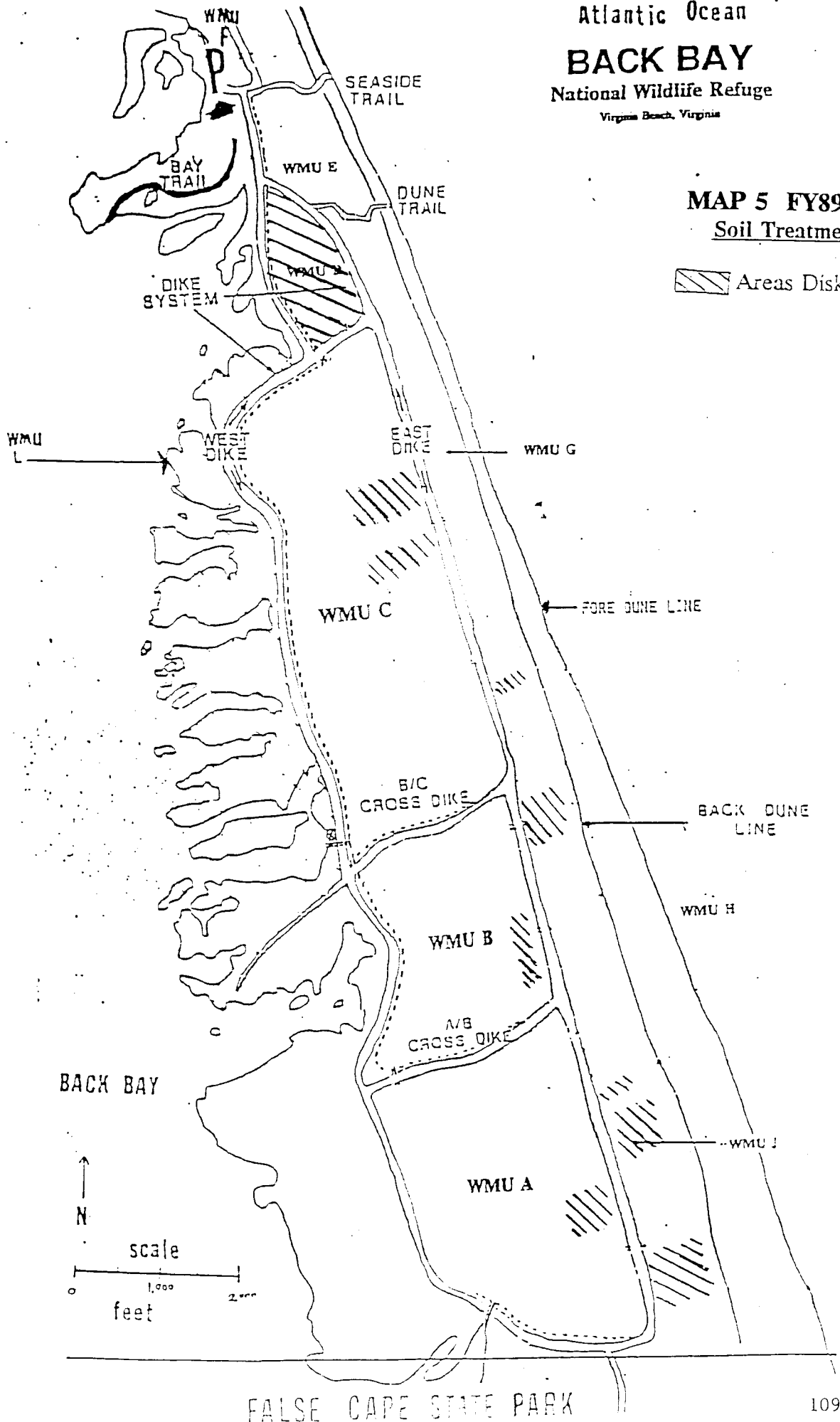
HEAD

BAY

Atlantic Ocean
BACK BAY
National Wildlife Refuge
Virginia Beach, Virginia

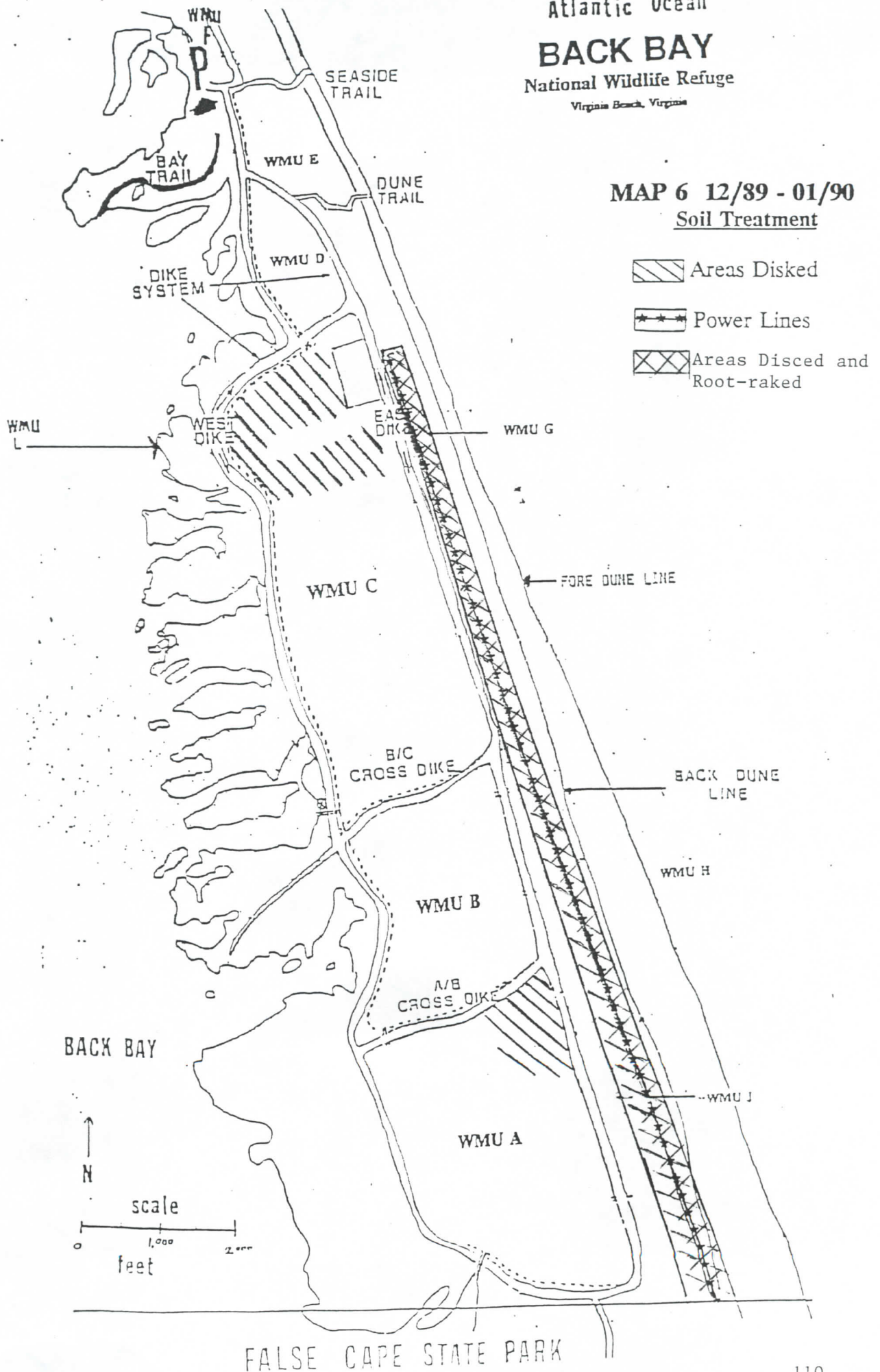
MAP 5 FY89-90
Soil Treatment

 Areas Disked



Atlantic Ocean
BACK BAY
National Wildlife Refuge
Virginia Beach, Virginia

MAP 6 12/89 - 01/90
Soil Treatment



Atlantic Ocean


BACK BAY

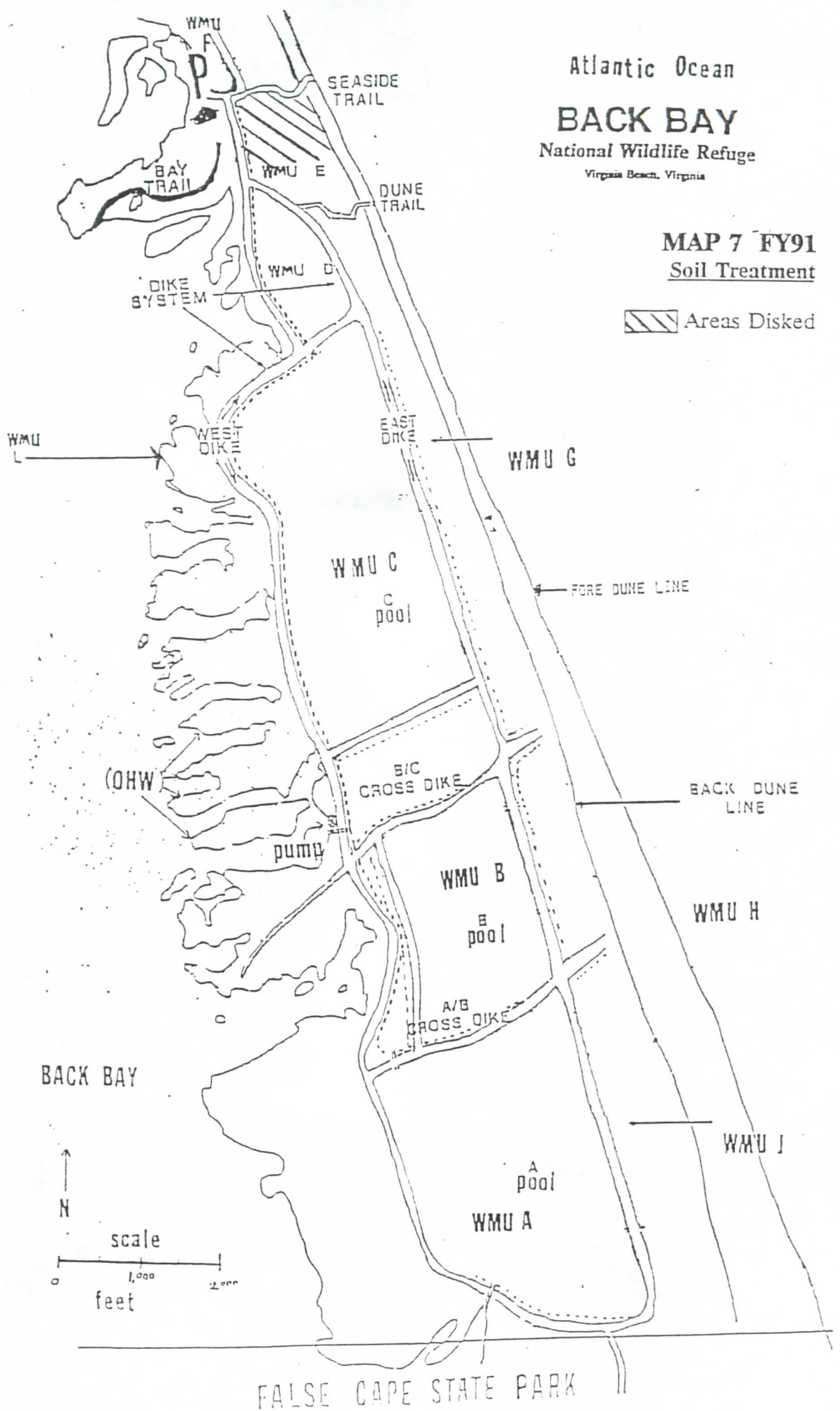
National Wildlife Refuge

Virginia Beach, Virginia

MAP 7 FY91

Soil Treatment

 Areas Disked



Atlantic Ocean


BACK BAY


National Wildlife Refuge


Virginia Beach, Virginia

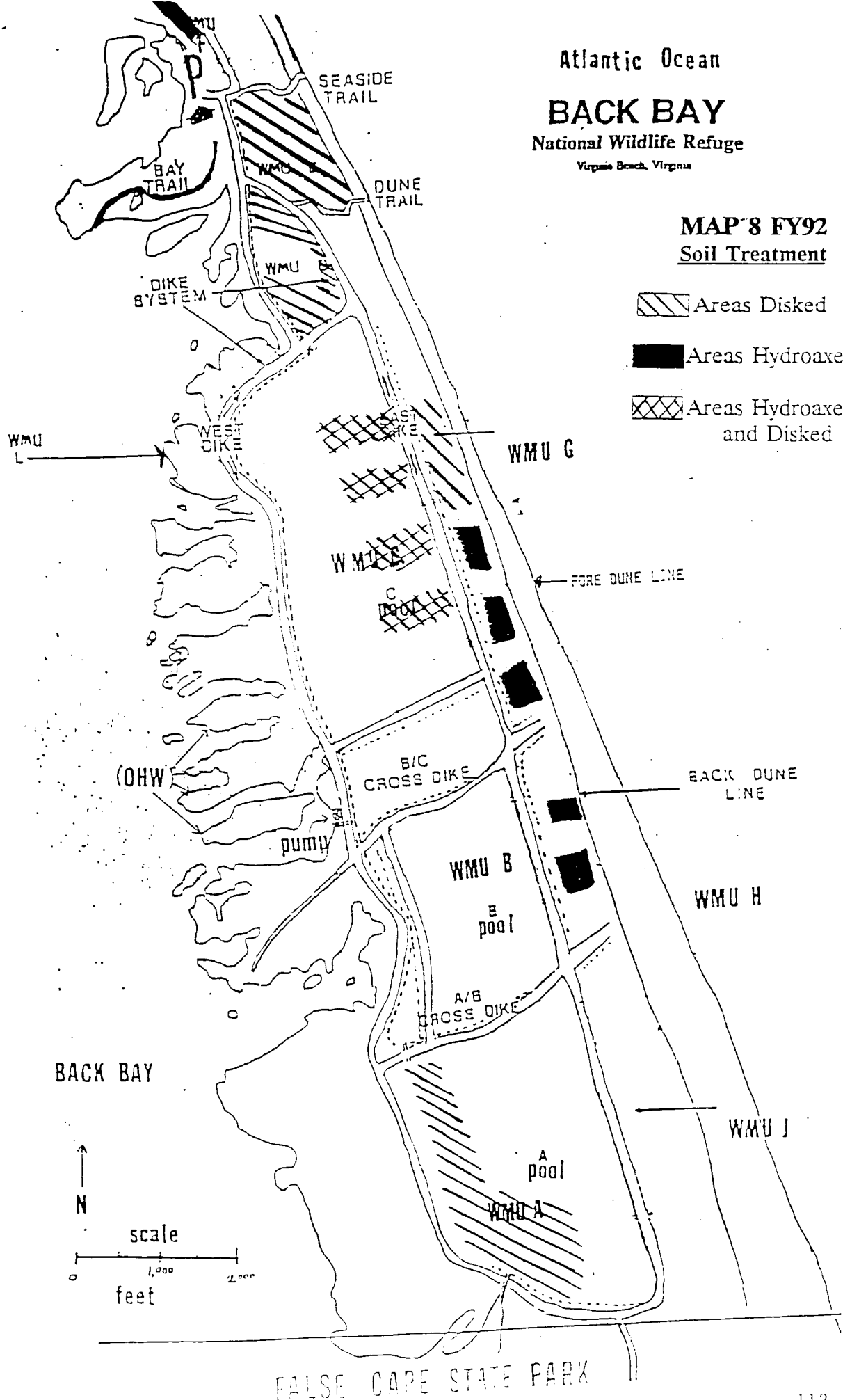
MAP 8 FY92

Soil Treatment

 Areas Disked

 Areas Hydroaxed

 Areas Hydroaxed and Disked




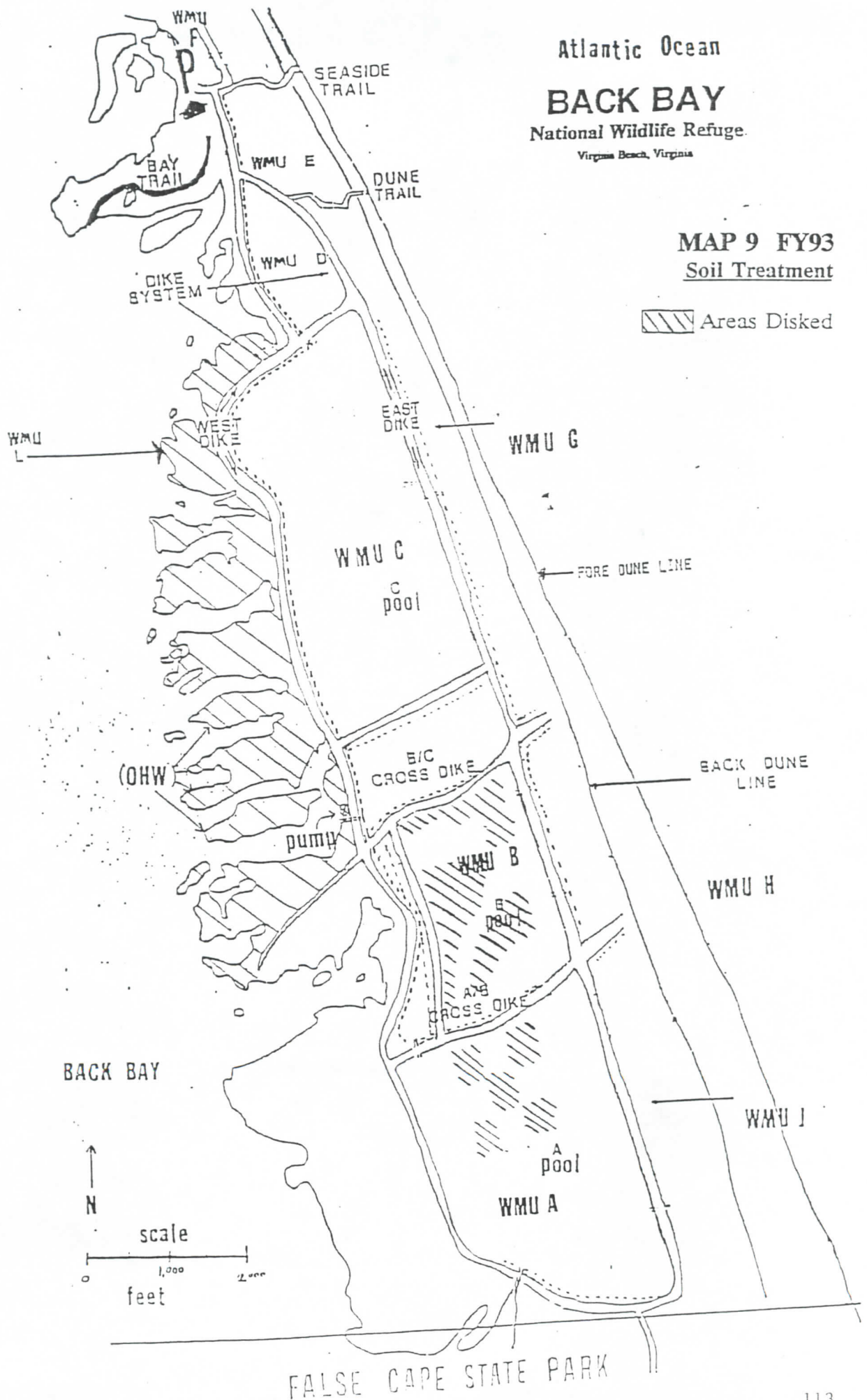
Atlantic Ocean

BACK BAY

National Wildlife Refuge
Virginia Beach, Virginia


MAP 9 FY93
Soil Treatment

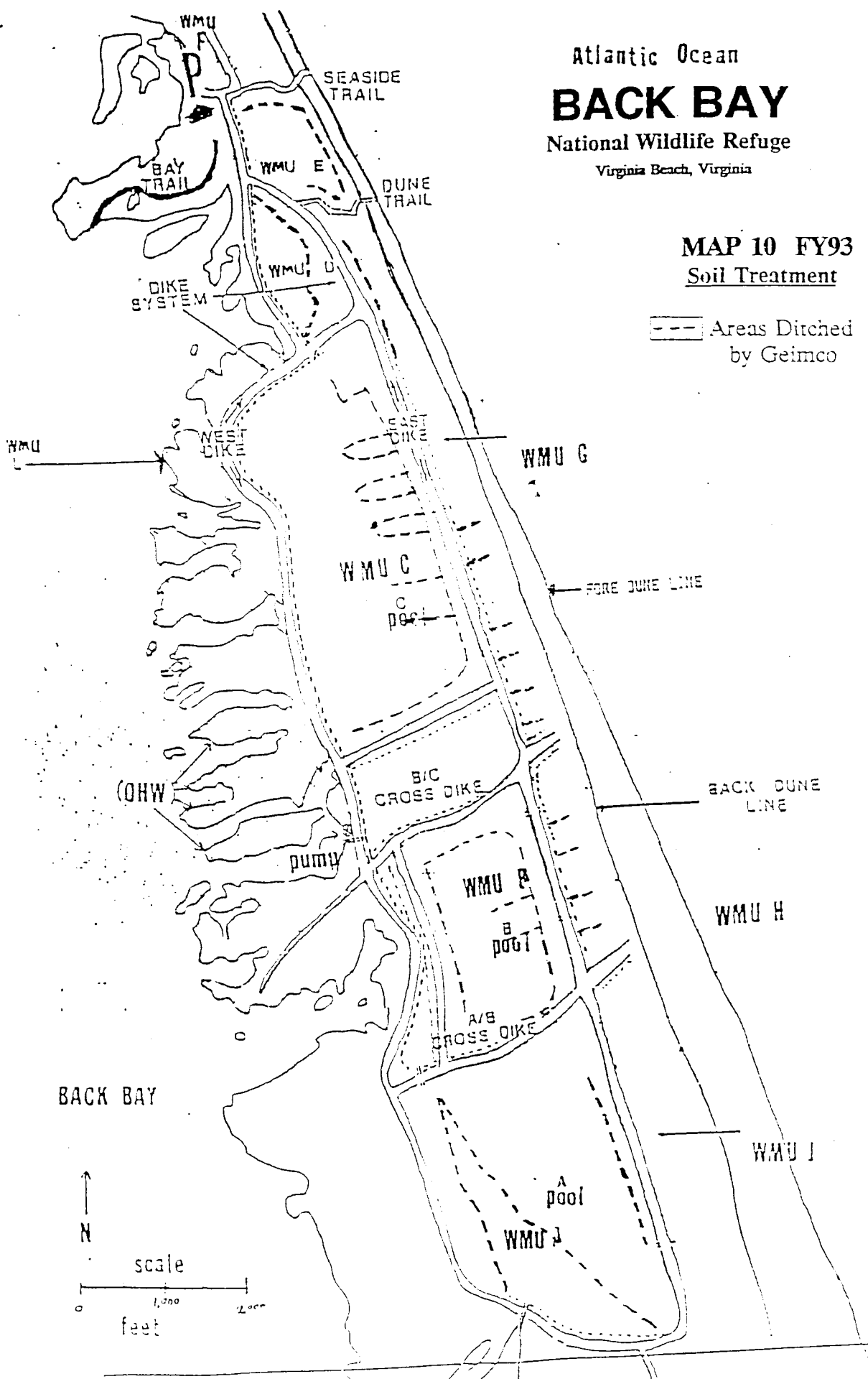
 Areas Disked



Atlantic Ocean
BACK BAY
National Wildlife Refuge
Virginia Beach, Virginia

MAP 10 FY93
Soil Treatment

 Areas Ditched
by Geimco



APPENDIX C

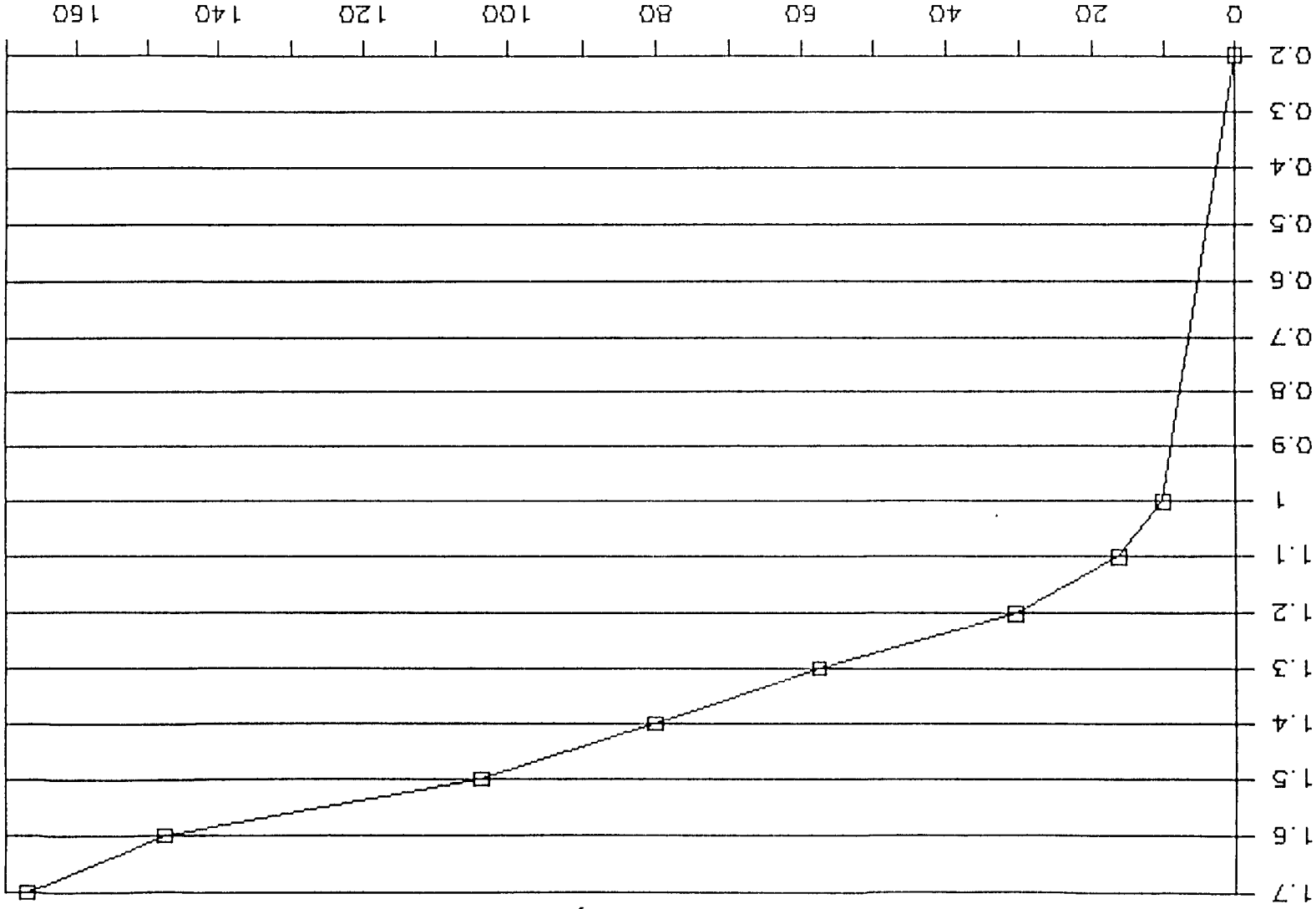
WMU ELEVATION - SURFACE AREA & CAPACITY CURVES & VOLUMES

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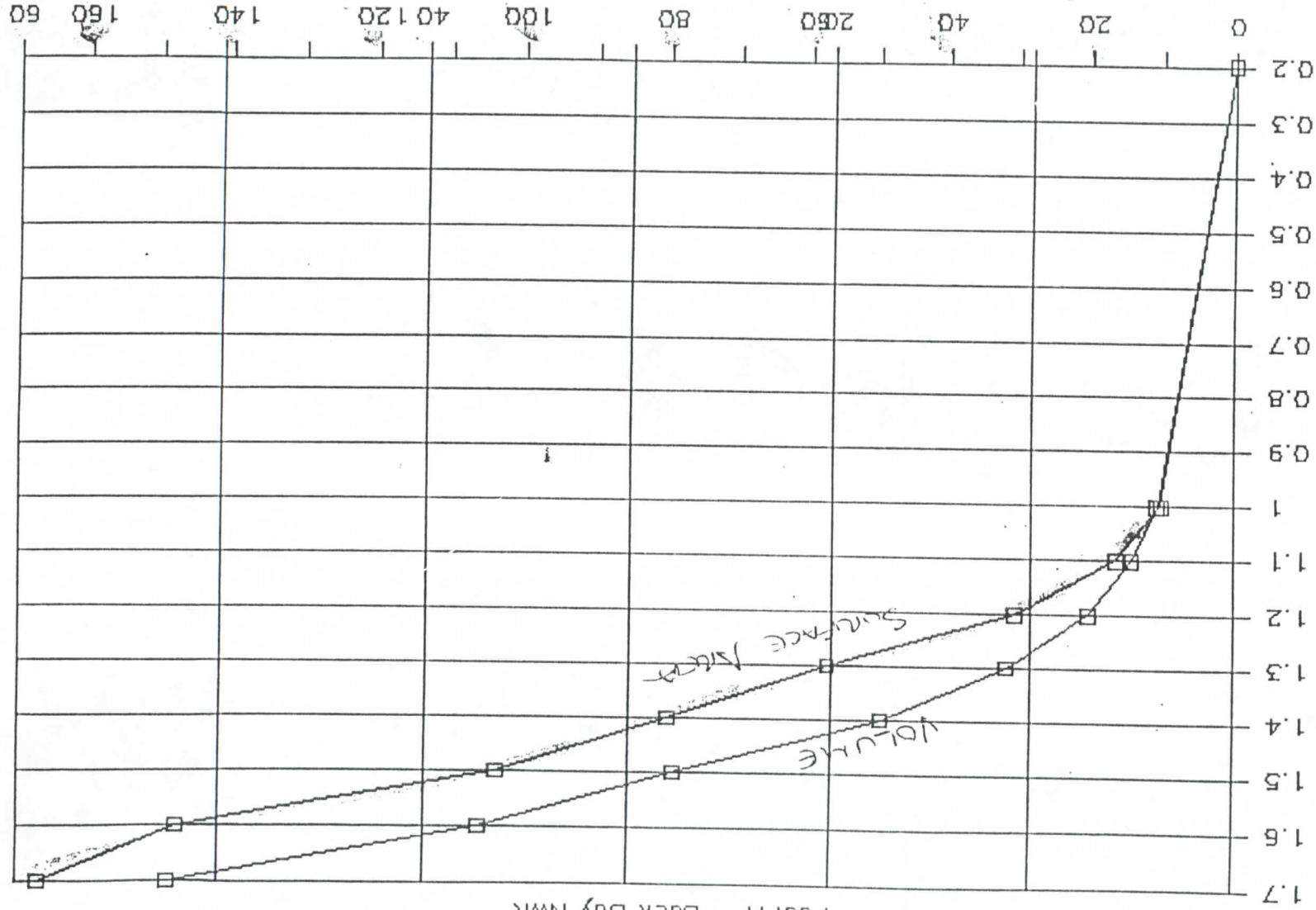
Elevation - Surface Area

Pool A - Back Bay NWR

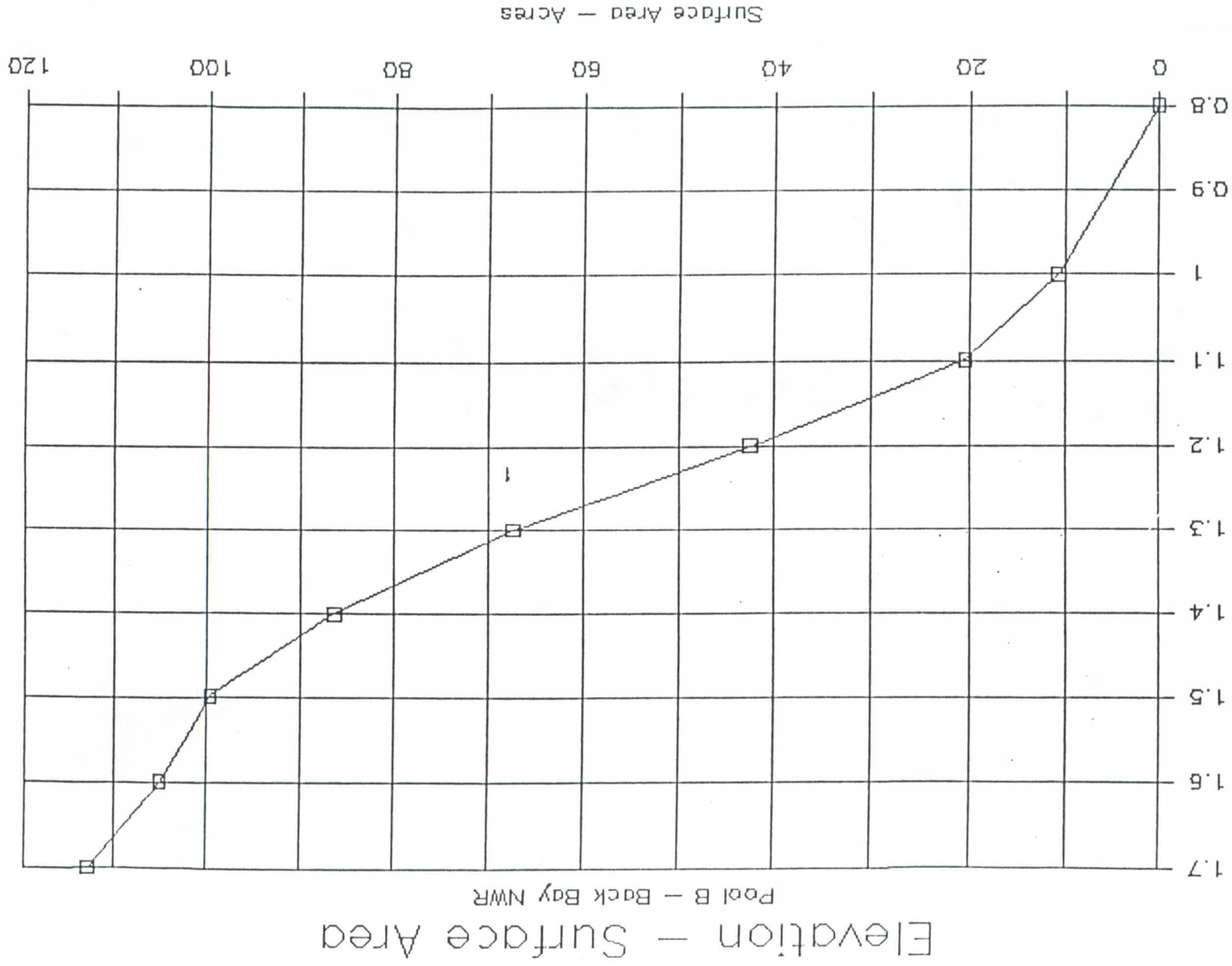


Elevation - Surface Area

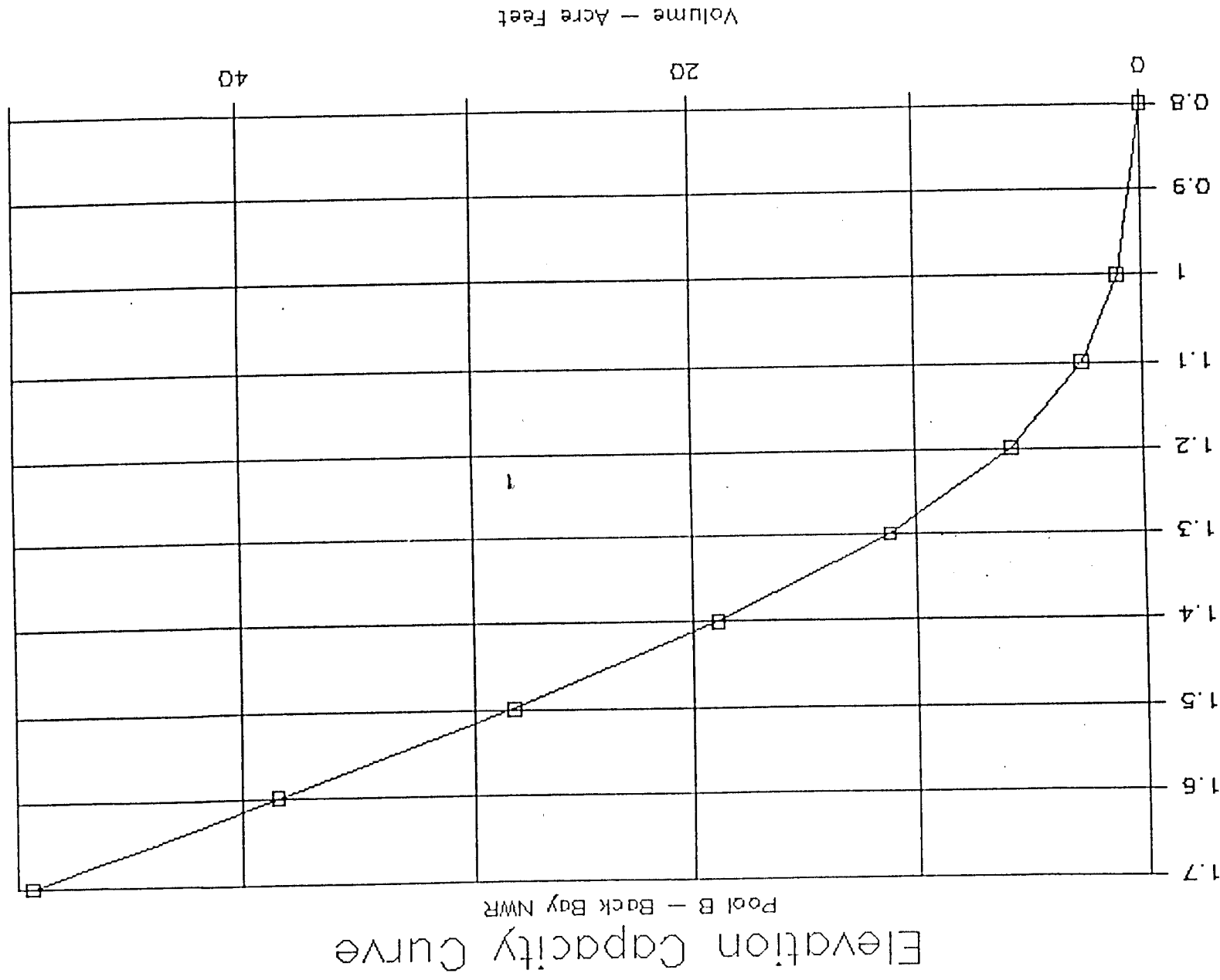
Pool A - Back Bay NWR



Elevation — Feet Above NGVD

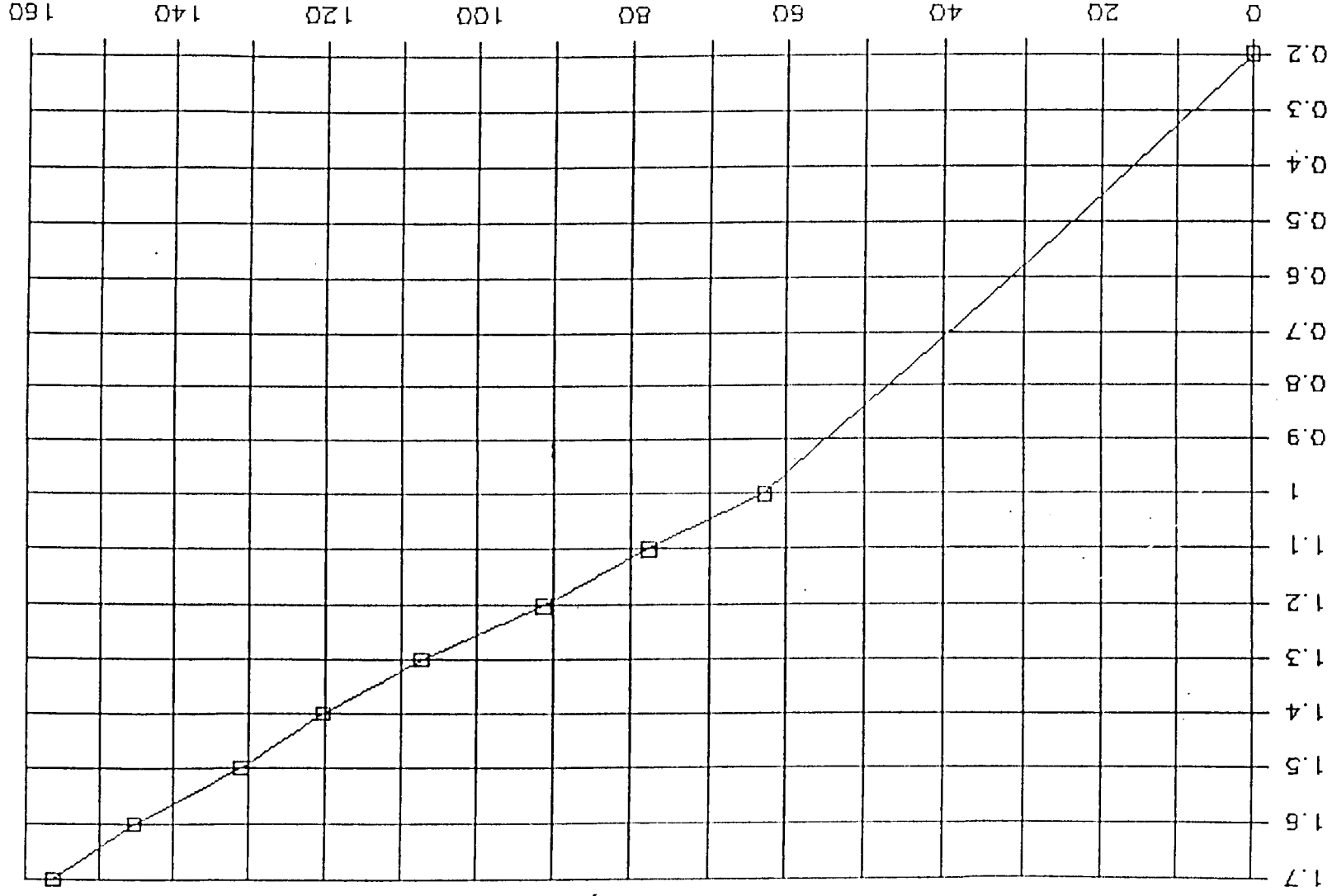


Elevation - Feet above NGVD

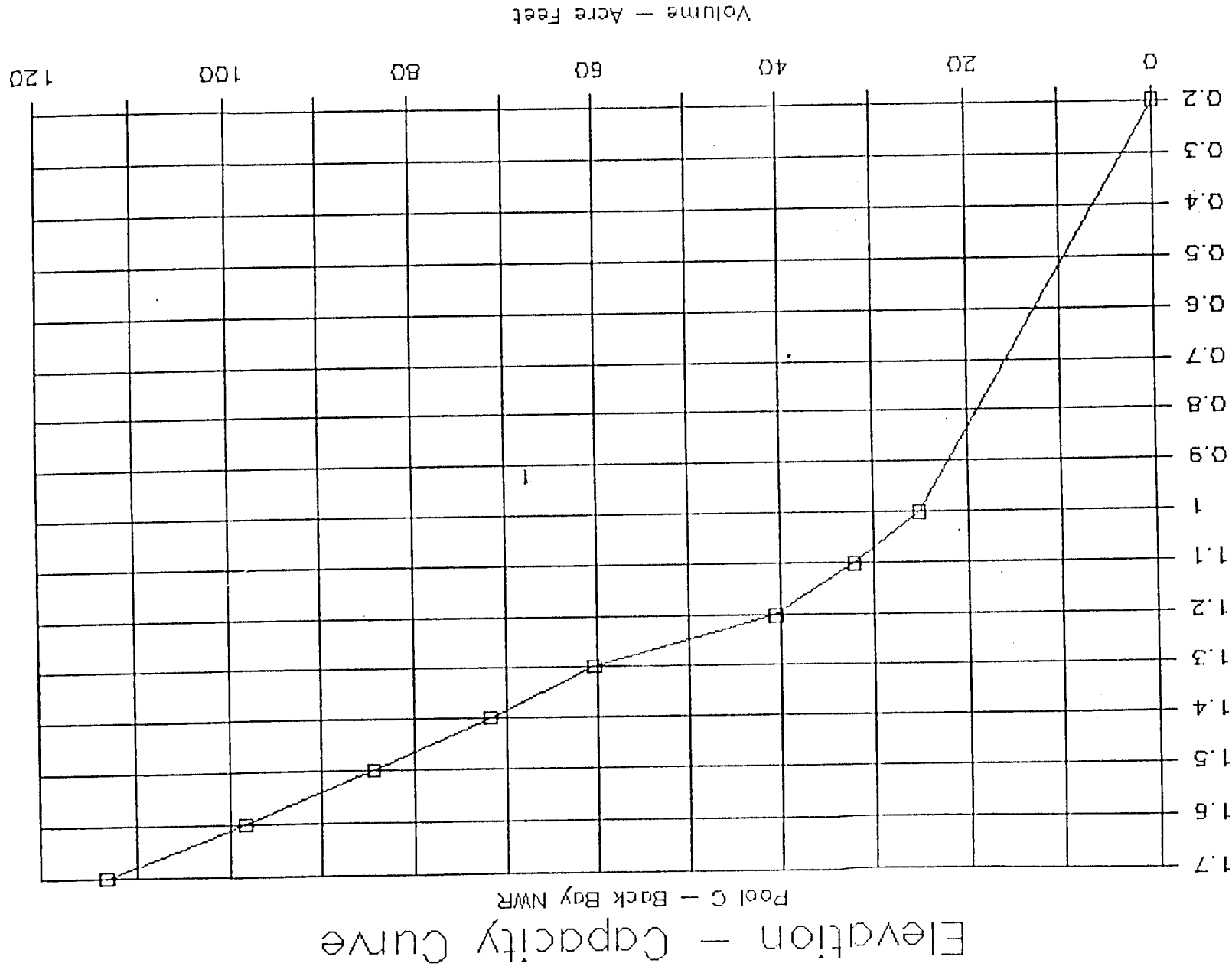


Elevation - Surface Area

Pool C - Back Bay NWR

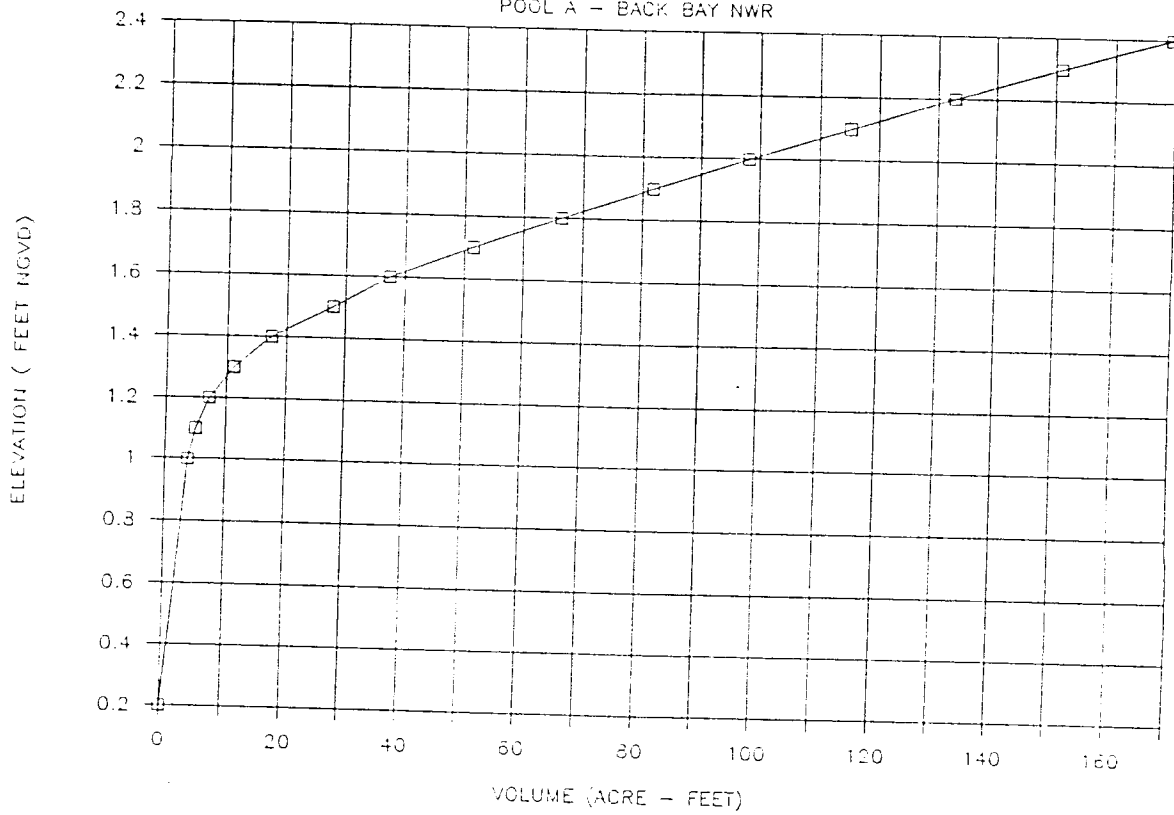


Elevation — Feet Above NGVD



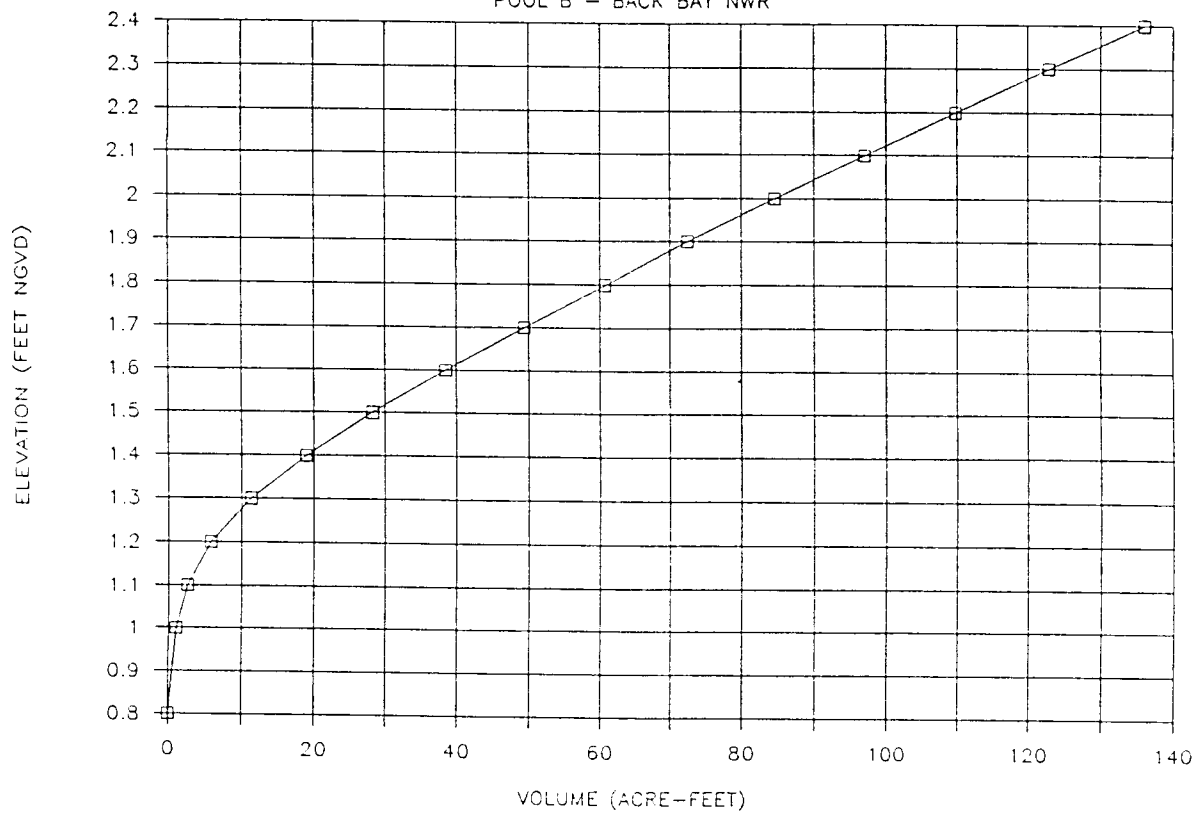
VOLUME — DEPTH CURVE

POOL A — BACK BAY NWR



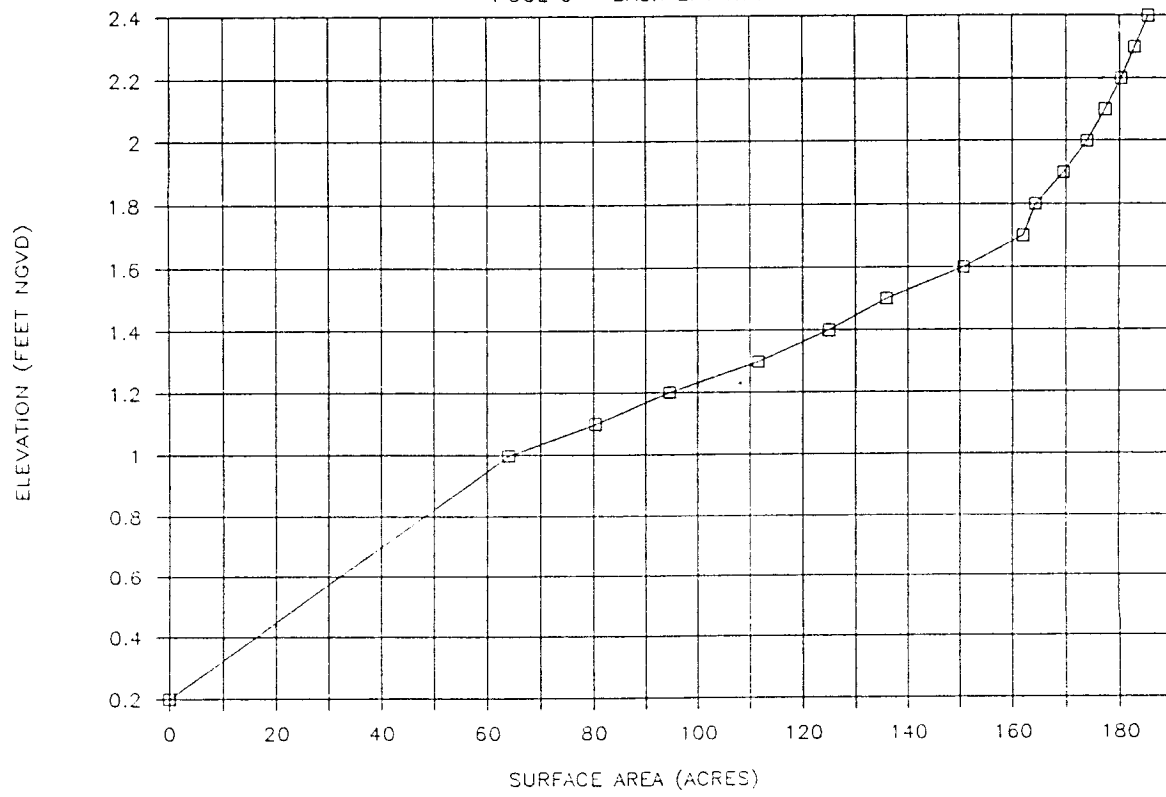
VOLUME - DEPTH CURVE

POOL B - BACK BAY NWR



SURFACE AREA — DEPTH CURVE

POOL C — BACK BAY NWR



APPENDIX D

Page Number

1990 WATER MANAGEMENT PROGRAM - BACK BAY NWR.....126

DATE:

FROM: Refuge Manager, Back Bay NWR

SUBJECT: FY 1990 - Marsh and Water Management Program

TO: Associate Manager - Refuges South

Attached is the Back Bay NWR FY 90, Marsh and Water Management Program. This program is an attempt to improve management of the nearly 1,000 acres of habitat which can be managed on the barrier spit portion of the Refuge. Some additional management is planned (primarily fire-oriented) in MSU's K and L (Bay Islands).

Through the implementation of this labor intensive annual program, the refuge will be able to utilize equipment and supplies purchased in FY 87, 88 and 89 to improve waterfowl habitat in refuge marshes.

This program follows the outline presented in 6RM2 as closely as possible. This program was expanded to allow for coverage of force account management activities, which the outline does not allow for. Planned elevations are covered in Table 1. The justification for these planned water levels is adequately outlined in the plan. To re-state the reasons for management in the program would be redundant.

Prepared By: _____ Date: _____

Submitted By: _____ Date: _____
Refuge Manager

Reviewed By: _____ Date: _____

Approved By: _____ Date: _____
Associate Manager-RFS

ANNUAL MARSH AND WATER MANAGEMENT PROGRAM - FY 90

I. INTRODUCTION: Marsh and water management activities have been conducted for nearly thirty years at Back Bay NWR. Annual programs were submitted for many years. In the early 1970's the management effort was de-emphasized due to the shift in administration of the Motor Vehicle Access Permit Program. In the era when annual programs were non-existent, managers apparently carried out water level manipulations and management activities based on the memories and knowledge of the staff (maintenance). In 1985 an annual program was prepared which basically outlined the current management regime.

The 1985 program was generally followed during 1986 - 1988. During that time, slight changes in the management effort occurred. The reasoning for the changes was to provide managers with information from which they could improve the program. Based on this experience and a renewed desire to improve marsh and water management efforts at Back Bay NWR, the March and Water Management Plan was totally revised during FY 88. This program is the second annual program proposed within the framework of the new plan.

II. ANALYSIS OF 1988 PROGRAM ACTIVITIES

1989 was another year of learning for improvement in water management activities at Back Bay NWR. Based on our experience in 1987 (A Pool), summer impoundment water levels were held at higher levels than in previous years. Rather than drawing levels down to 0.5-1.0' above sea level (NGVD) as has been done in previous years, levels were maintained at 1.0-1.5' above sea level. This management regime resulted in maintenance and enhancement of wetland vegetation in the three primary impoundments (A, B, and C). Past water management effort had been oriented towards production of upland plants (1974 program) that would then be flooded in the fall. 1988 efforts, however, were oriented in favor of producing high quality wetland vegetation. The result of these slightly higher water levels has been an excellent growth of three-squares and other wetland dependent species as well as a decrease in upland oriented species.

The dredging project was halted during late 1988 and the refuge now has a dependable water source for the twin 6,000 gpm pumps located in the Southwest corner of C-Pool. The new channel is approximately 1500 ft long, 30 ft wide, and 6 ft deep.

Perhaps the most significant event during FY89 was acquiring all the necessary permits from Federal, State and local authorities to begin the Impoundment Rehabilitation Project (See Appendix I). Instead of belaboring the project here, all information concerning the what, when, where and why is contained in Appendix I. Upon project completion (Fall 1991) Back Bay NWR will finally have the water management flexibility that is vital in order to

maximize habitat management efforts. The project will also create an additional 300+ acres of wetland east of the east dike, provide brood habitat, and provide additional wood duck nesting habitat.

Disking efforts were greatly increased during the past year (See Appendix II)

Jan	WMU E	25 Acres
Aug	WMU A, B, C, D	50 Acres
Oct	Long Island	Discussed in later sections
Nov	WMU G, H, I	10 Acres

Disking was performed with a Kewanee disk and the JD 550A Dozer. Using a dozer to pull a disk is very rough on the equipment. Over \$5,000 was spent on dozer repairs. In the future, serious thought should be directed toward the purchase of a suitably sized 4x4 tractor.

During August 21 and 23 Japanese Millet was planted on 35 acres of disked areas (See Appendix II). This was done at the suggestion of the Zone Biologist instead of letting natural vegetation (i.e. three square bullrush) volunteer. The millet plants was a dismal failure in that it never reached a height of over 4" tall. It is not known what was the cause for failure (i.e. late planting, seed viability, deer browsing).

WMU E was disked in January to expose rootstocks and immediately 1500 snow geese moved into this area to feed. They remained for about 10 days.

Long Island - Work began in August with the mowing of the 35 acre field using a sickle bar on the Ford tractor. Disking could not be performed due to the amount of dead gras/debris (mostly johnson grass and goldenrod). The area was burned during September. the field was then disked twice. During the first week of October, the area was fertilized and planted in winter wheat at a rate of one bushel/acre. By the end of October the wheat was 4" high and Canada Geese were browsing heavily. By the end of December, Snow Geese were also using the area and created several eatouts.

Prescribed Burns

In addition to the Long Island burn previously discussed, one other burn took place on January 19 on the "finger" east of C-Pool (See Appendix II). This 75 acre area was also burned during FY88. The purpose of the burn was to expose rootstocks of the black needlerush to encourage feeding on the exposed rootstock by snow geese;

2. To return nutrients to the soil; and

3. To improve the vegetation composition of the area (i.e. from needlerush to three square).

Snow Geese did use the area immediately after the burn as 400 geese were seen feeding the blackened area during late January. Large flocks, however, did not use the area, most probably because the "fingers" are small and large numbers of geese were wary of concentrating in these small areas with obstructed views. Nutrients were returned to the soil over 80% of the burn area (20% was not burned because it contained pine tree thickets and we chose not to burn them). The vegetation composition was not significantly altered as black needle rush still predominates the area.

In conclusion two of the three objectives were met and future decisions to burn this area must weight the relative benefits (feeding a small flock of snow geese, and returning nutrients) versus the cost.

Management activities in FY89 provided important habitat (locally) for migratory waterfowl and wetland-dependant wildlife. Water levels were maintained at 1.3' to 2.3' above MSL. Habitat was provided for: (peaks) - 27,600 snow geese (30 yr. high), 1,065 mallards, 519 black ducks, 505 pintails, 554 swans. Appendix IV shows objective levels for FY89. ~~Appendix V shows the actual levels.~~

III. Planned Water Management for FY90

Due to the impoundment rehabilitation project, water levels will greatly deviate from past regimes (See Appendix III). Basically B & C Pools will be drained on or about March 1 to discourage nesting efforts and to facilitate working in these areas with heavy equipment during April. We hope to keep water in A-Pool in order to provide some undisturbed habitat during the fall and winter. Hot foots, such as Japanese millet, milo, etc. may be planted in suitable areas of B & C Pools to mitigate the loss of natural foods in these pools due to construction.

The Marsh and Water Management Plan identifies mechanical control as a viable technique to improve waterfowl habitat. The recently acquired Kewanee disk and 550A root rake will allow Refuge personnel to perform mechanical control techniques. Black needlerush is a low priority waterfowl food (snow geese will feed on tubers) and is actively controlled via refuge activities. Large amounts of Myrica complex brush areas are evident in the eastern edges of Pools A, B, and C and in WMU's east of the East Dike. Root raking and burning, followed by flooding will discourage growth of Myrica sp. and improve habitat for waterfowl. It is expected that the impoundment project will result in more than 100 acres being worked this year.

Prescribed Burning

Twelve prescriptions have been submitted. The impoundment project will necessitate the burning of over 365 acres (WMU's G, H, J). We also expect to burn all of the islands for which we have prescriptions with the possible exception of South Long Island. With the recent addition of a refuge airboat and borrowing a flame thrower from Mackay Island NWR, this optimistic goal should be achieved. The burns should take place in January or February. The main purpose of burning this island is to expose the root stock of black needle rush, which predominates the island.

Long Island

Work on Long Island will follow-up on last years efforts. The island is managed primarily for snow and Canada geese. The field is now in very good condition for cultivating. Plans are to see what vegetation volunteers. If johnson grass appears (as it is expected) it will be treated with round-up using a wiper. The area will then be mowed, disked, and planted into a perennial seed mix, unless a suitable mix volunteers. Plan B would involve a mowing/burning/disking/planting winter wheat or rye regime similar to last year. Other options include simply mowing the field during late September and/or disking to expose the tuber rootstock of the johnson grass to see if geese will feed on them.

These options are far less than desirable but may become a reality due to manpower conflicts with the impoundment project.

Evaluation and Monitoring

During FY89 the following evaluation/monitoring procedures were carried out.

Pool impoundment levels and salinity - Water elevation data was collected bi-weekly (often more frequently). See Appendix V.

Back Bay water quality - The waters of Back Bay were tested weekly for temp, pH, clarity, salinity, dissolved oxygen, phosphates and nitrate - results were sent to the Pamlico-Tar River Foundation Coordinator.

Prescribed Burns - Evaluation was contained in the Fire Report completed immediately following the burn and evaluated the percent of area burned, weather data, etc. Also, results are contained in the annual Marsh & Water Program in which the biological aspect of the burn are evaluated (See section of the report).

Aerial Photos - Oblique aerial photos were taken routinely as a part of the monthly aerial waterfowl survey (September through April). This qualitative technique is very beneficial in providing a historical profile

and documenting management (i.e. disking, burning) activities at very little cost to the refuge.

Cover Type Map - A covertime map of Plum Tree Island was completed by seasonal Bio Tech Andres (See Appendix VI).

No vegetation transects were completed during FY89.

Evaluation/monitoring for FY90 (as outlined in the Marsh & Water management Plan) will include all of the above techniques plus the addition of permanent photo points. If time and manpower exists, a cover type map will be prepared for Back Bay NWR and vegetation transects conducted, as outlined in the recently submitted Marsh and Water plan.

PHILLIPS:ruiz:June 13, 1990:Juana #2:M&WPRO.JP

old 9=0

U.S. FISH AND WILDLIFE SERVICE

REFUGE MANUAL

CURRENT

6 RM 2 Exhibit 1

HABITAT MANAGEMENT

Annual Water Management Program Outline

Page 3

A POOL

A.1. Water Surface Elevations
and Salinity for Past Year (FY 88)B.2. Planned Elevation and Salinity
for Program Year (FY 89)

Date	Water Surface Elevations	*Salinity (% of Sea Water)	Water Surface Elevation	*Salinity Objective
Jan. 1	-- 1.9	N/A	2.1	5%
15	-- 1.7	N/A	2.1	5%
Feb. 1	-- 1.8	N/A	2.3	5%
15	-- 1.9	N/A	2.3	5%
Mar. 1	-- 1.7	N/A	2.3	5%
15	-- 1.0	N/A	2.1	5%
Apr. 1	-- 1.4	N/A	2.1	2%
15	-- 1.8	N/A	2.1	2%
May 1	-- 1.7	N/A	1.8	2%
15	-- 1.9	N/A	1.8	2%
June 1	-- 1.5	N/A	1.4	2%
15	-- 1.4	N/A	1.4	2%
July 1	-- 1.4	N/A	1.4	2%
15	-- 1.6	N/A	1.4	2%
Aug. 1	-- 1.6	N/A	1.5	2%
15	-- 1.5	N/A	1.5	2%
Sept. 1	-- 1.5	N/A	1.7	2%
15	-- 1.6	N/A	1.7	2%
Oct. 1	-- 1.4	N/A	1.7	2%
15	-- 0.0	N/A	1.7	5%
Nov. 1	-- 0.0	N/A	1.9	5%
15	-- 1.0	N/A	1.9	5%
Dec. 1	-- 1.1	N/A	1.9	5%
15	-- 1.7	N/A	1.9	5%
31	-- 1.5	N/A	2.1	5%

*To be used for pools approved for brackish water management.

0 = sea level

N/A = not available

Salinity objectives are maximums.

Release:

000 March 12, 1982

NATIONAL WILDLIFE REFUGE SYSTEM

U.S. FISH AND WILDLIFE SERVICE

REFUGE MANUAL

HABITAT MANAGEMENT

6 RM 2 Exhibit 1

Annual Water Management Program Outline

Page 3

B POOL

A.1. Water Surface Elevations
and Salinity for Past Year (FY 88)

B.2. Planned Elevation and Salinity
for Program Year (FY 89)

Date	Water Surface Elevations	*Salinity (% of Sea Water)	Water Surface Elevation	*Salinity Objective
Jan. 1--	2.0	N/A	1.9	5%
15--	1.8	N/A	2.1	5%
Feb. 1--	1.8	N/A	2.1	5%
15--	1.9	N/A	2.1	5%
Mar. 1--	1.7	N/A	2.1	5%
15--	1.5	N/A	1.9	5%
Apr. 1--	1.2	N/A	1.9	2%
15--	1.8	N/A	1.7	2%
May 1--	1.6	N/A	1.5	2%
15--	1.9	N/A	1.5	2%
June 1--	1.7	N/A	1.3	2%
15--	1.4	N/A	1.3	2%
July 1--	1.6	N/A	1.3	2%
15--	1.6	N/A	1.3	2%
Aug. 1--	1.6	N/A	1.5	2%
15--	1.4	N/A	1.5	2%
Sept. 1--	1.6	N/A	1.5	2%
15--	1.7	N/A	1.5	2%
Oct. 1--	1.3	N/A	1.7	2%
15--	1.3	N/A	1.7	5%
Nov. 1--	2.0	N/A	1.7	5%
15--	1.7	N/A	1.7	5%
Dec. 1--	2.1	N/A	1.9	5%
15--	2.1	N/A	1.9	5%
31--	2.0	N/A	1.9	5%

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Release:

000 March 12, 1982

NATIONAL WILDLIFE REFUGE SYSTEM

U.S. FISH AND WILDLIFE SERVICE

REFUGE MANUAL

HABITAT MANAGEMENT

6 RM 2 Exhibit 1

Annual Water Management Program Outline

Page 3

C POOL

A.1. Water Surface Elevations and Salinity for Past Year (FY 88) B.2. Planned Elevation and Salinity for Program Year (FY 89)

Date	Water Surface Elevations	*Salinity (% of Sea Water)	Water Surface Elevation	*Salinity Objective
Jan. 1--	2.0	N/A	1.9	5%
15--	1.8	N/A	2.1	5%
Feb. 1--	1.8	N/A	2.1	5%
15--	1.9	N/A	2.1	5%
Mar. 1--	1.7	N/A	2.1	5%
15--	1.5	N/A	1.9	5%
Apr. 1--	1.0	N/A	1.9	2%
15--	1.6	N/A	1.7	2%
May 1--	1.6	N/A	1.5	2%
15--	1.9	N/A	1.5	2%
June 1--	1.7	N/A	1.3	2%
15--	1.5	N/A	1.3	2%
July 1--	1.5	N/A	1.3	2%
15--	1.5	N/A	1.3	2%
Aug. 1--	1.4	N/A	1.5	2%
15--	1.4	N/A	1.5	2%
Sept. 1--	1.7	N/A	1.5	2%
15--	1.7	N/A	1.5	2%
Oct. 1--	1.3	N/A	1.7	2%
15--	1.3	N/A	1.7	5%
Nov. 1--	1.9	N/A	1.7	5%
15--	1.7	N/A	1.7	5%
Dec. 1--	2.0	N/A	1.9	5%
15--	2.1	N/A	1.9	5%
31--	1.9	N/A	1.9	5%

*To be used for pools approved for brackish water management.

0 = sea level

N/A = not available

Salinity objectives are maximums.

DATE: October 7, 1988

FROM: Refuge Manager, Back Bay NWR

SUBJECT: FY 1989 - Marsh and Water Management Program

TO: Associate Manager - Refuges South

Attached is the Back Bay NWR FY 89, Marsh and Water Management Program. This program is an attempt to improve management of the nearly 1,000 acres of habitat which can be managed on the barrier spit portion of the Refuge. Some additional management is planned (primarily fire-oriented) in MSU's K and L (Bay Islands).

Through the implementation of this labor intensive annual program, the refuge will be able to utilize equipment and supplies purchased in FY 87 and 88 to improve waterfowl habitat in refuge marshes.

This program follows the outline presented in 6RM2 as closely as possible. This program was expanded to allow for coverage of force account management activities which the outline does not allow for. Planned elevations are covered in Table 1. The justification for these planned water levels is adequately outlined in the Plan. To re-state the reasons for management in the program would be redundant.

Submitted By: *Leahony D. Legn* Date: *10-7-88*
Refuge Manager

Reviewed By: *Richard Sojda* *REC'D WITH REO. BIOL. 3-16-89* Date: *3-8-89*
rec'd 2-21-89

Approved By: *Thomas J. McAndrew* Date: *3-17-89*
Associate Manager - RFS

cd: FB-5
3-20-89

ANNUAL MARSH AND WATER MANAGEMENT PROGRAM - FY 89

I. INTRODUCTION: Marsh and water management activities have been conducted for nearly thirty years at Back Bay NWR. Annual programs were submitted for many years. In the early 1970's the management effort was de-emphasized due to the shift to administration of the Motor Vehicle Access Permit Program. In the era when annual programs were non-existent, managers apparently carried out water level manipulations and management activities based on the memories and knowledge of the staff (maintenance). In 1985 an annual program was prepared which basically outlined the current management regime.

The 1985 program was generally followed during 1986 - 1988. During that time, slight changes in the management effort occurred. The reasoning for the changes was to provide managers with information from which they could improve the program. Based on this experience and a renewed desire to improve marsh and water management efforts at Back Bay NWR, the Marsh and Water Management Plan was totally revised during FY 88. This program is the first annual program proposed within the framework of the new plan.

II. ANALYSIS OF 1988 PROGRAM ACTIVITIES

1988 was another year of learning for improvement in water management activities at Back Bay NWR. Based on our experience in 1987 (A Pool), summer impoundment water levels were held at higher levels than in previous years. Rather than drawing levels down to 0.5-1.0' above sea level (NGVD) as has been done in previous years, levels were maintained at 1.0-1.5' above sea level. This management regime resulted in maintenance and enhancement of wetland vegetation in the three primary impoundments (A, B, and C). Past water management effort had been oriented towards production of upland plants (1974 program) which would then be flooded in the fall. 1988 efforts, however, were oriented in favor of producing high quality wetland vegetation. The result of these slightly higher water levels has been an excellent growth of three-squares and other wetland dependent species as well as a decrease in upland oriented species.

Efforts continued throughout the year to improve the refuge water supply. The channel dredging project, initiated in 1987, is an attempt to improve the capability of the refuge to flood managed wetlands. Upon completion, a 1500' channel approximately 30' wide by 6.5 feet deep, will provide Back Bay water to the twin 6,000 gallon electric pumps located in the south end of C Pool. In early FY 88, partial completion of this channel enhanced the ability of the refuge to respond to the needs of resting and wintering waterfowl. Now, when bay water levels fall (through the influence of wind tides in the early fall) refuge personnel are able to pump into the impoundments via the channel and pumps.

In FY 87, an Advanced Procurement Planning Project (APP) was initiated to evaluate the need for, and the appropriate design of, inter-impoundment water control structures. With the implementation of the dredging project, the need to improve flow between pools A, B, and C, and to the marshes east of the East Dike Road, became evident. The APP was initiated to address this need. A verbal report was received on this project in early 1988. This report (from RO-EN) recommended the construction of a storage pool in C-Pool and a diked flume in B-Pool to provide positive water flow (N→S) throughout the impoundments.

Due to a lack of adequate data, the Regional Engineer recommended that additional elevation data be gathered on Refuge impoundments. This data was gathered by Regional Surveyors in the spring of 1988. This effort demonstrated that bottom elevations of refuge impoundments range from about sea level to 2.0 feet above sea level. However, the predominant elevation is between 1.0-1.5' above sea level. This data has enabled the Refuge to fine tune it's management effort and improve wetland habitats.

In FY 87 and FY 88, Back Bay received ARMM funding in the amount of 50,000 per year. These funds allowed the Refuge to improve it's capability to manage Refuge resources. In the absence of the knowledge required to make major changes in management, and taking into account the lack of data available to managers, the decision was made to expend the money to improve the Refuge's equipment and impoundment management materials. Major procurements in equipment, vehicles, and the like in FY 87 and FY 88 included the following; Ford 555B Backhoe Loader, 4WD ATV, Allis-Chalmers Front-End Loader, Kewanee disk, 4WD Dump Truck, ten 24" aluminum water control structures, salinity tester, IBM/AT compatible computer, road gravel, level and tripod, and other miscellaneous supplies.

Management activities in FY 88 provided important habitat (locally) for migratory waterfowl and wetland-dependent wildlife. Water levels were maintained at 1.3 to 2.0' above MSL. Habitat was provided for; (peaks) -- 6,000 snow geese, 1,000 mallards, 2,500 black ducks, 500 pintails, 500 blue-winged teal, 1,550 green-winged teal, and other various waterfowl species. Table 1 shows water levels maintained during FY 88.

III. PLANNED WATER MANAGEMENT FOR FY 89

The FY 89 water management effort will build on the experience gained in 1987 and 1988. Efforts will be in accordance with the recently submitted Marsh and Water Management Plan. Table 1 (Attached) shows planned water levels for FY 89 for the three major Moist Soil Units. Our ability to control levels in Units D, E, G, H, and J is minimal. Levels will be held as high as possible throughout the summer to encourage growth of wetland vegetation.

Efforts in FY 89 will also focus on improving our water distribution capabilities. These efforts will proceed as follows (listed in priority order):

1 -- Replace/Install New Water Control Structures.

Ten new aluminum, stop-log water control structures were purchased in FY 88. Concrete pipes to fit these structures are on hand. During FY 89, refuge personnel will attempt to install/replace as many WCS's as possible to enhance management of refuge Moist Soil Units. Attempts will be made to secure required permits during the winter months with construction activity planned for the months of April - September. Priorities will be for structures in the C/D Crossdike, D/E Crossdike, between C Pool and Unit G (East Dike), and between B Pool and Unit H. As structures are replaced, new water elevation guages will be set with a range of -3 to +4 feet (NGVD). Zero (0) will equal sea level (previously a guage reading of 9.0 equalled sea level).

2 -- Improve Ditches

Refuge ditches are inadequate to move water between units. Map D of the Refuge's Marsh and Water Management Plan illustrates planned ditches for refuge Moist Soil Units. As in task #1 above, permit applications will be submitted in the fall of 1988. Ditching activities will be performed using refuge equipment. Planned construction would occur in April - September 1989. Priorities will be identified in permit applications. In general, our efforts will be geared towards moving water east and south through refuge Moist Soil Units.

3 -- Disk Black Needlerush and Root Rake Wax Myrtle/Bayberry

The Marsh and Water Management Plan identifies mechanical control as a viable technique to improve waterfowl habitat. The recently acquired Kewanee disk and 550A root rake will allow Refuge personnel to perform mechanical control techniques. Black needlerush is a low priority waterfowl food (snow geese will feed on tubers) and is actively controlled via refuge activities. Large amounts of Myrica complex brush areas are evident in the eastern edges of Pools A, B, and C and in MSU's east of the East Dike. Root raking and burning, followed by flooding will discourage growth of Myrica sp. and improve habitat for waterfowl.

The goal for FY 89 will be to disk 25 acres of black needlerush during July and August - primarily in A Pool. Root raking of 15 acres of Myrica in B Pool and Unit G is planned for May and June.

4 -- Phragmites Control

In 1986 and 1987 Rodeo was applied to a total of approximately 50 acres of phragmites in the various, manageable Moist Soil Units. Elimination of phragmites is a goal of Marsh and Water Management. Follow-up spraying will be initiated on needed areas in September of 1989. Thirty gallons of Rodeo is on hand for this purpose. If additional chemical is available, control will be initiated on areas not previously sprayed in all Moist Soil Units.

5 -- Prescribed Burning

After many years of poor success in the use of prescribed fire, refuge personnel performed two successful prescribed burns in FY 88. In October, Units D and E were burned to promote late season herbaceous growth and improve habitat for wintering geese. Unit E was mowed prior to burning. In late May, the large (mostly upland) field on Long Island - Unit K - was successfully burned. This fire resulted in a nearly pure stand of Johnsongrass in the field.

Prescriptions in FY 89 will be submitted during October/November, 1988. Preliminary plans call for a prescribed burn of C Pool, burning previously sprayed phragmites stands, and burning Bay marshes in Moist Soil Units K and L. Most prescribed burning is planned for the winter months when the fuel is drier and water levels (bay marshes) are lower. Prescribed fire is primarily utilized to improve Snow Goose habitat (immediate benefit) and to retard succession to improve marshes for ducks, geese, and wading birds.

IV. EVALUATION/MONITORING

New vegetation transect procedures will be implemented during FY 89. Attachment #1 of the Marsh and Water Management Plan outlines the vegetation transect procedures which will be utilized. This transect technique involves measuring changes in Moist Soil Unit habitat by comparing cover class changes over time along permanent transect lines. When transect lines are established, they will be recorded permanently and appended to the Marsh and Water Management Plan. Transects will be established and run during August of 1989.

Water elevation data will be gathered periodically throughout the year. In the past, guage readings have been taken daily, which is excessive in terms of program needs. Effective October 1988, guage readings will be taken on each Monday, and on the first and fifteenth of each month. Readings will also be taken after major storm events. Data will be recorded on the attached form (Table 2). To the maximum extent practicable guage readings will be obtained while performing other normal duties (ex. wildlife inventories).

TABLE 2

To R.O. (RF) for:

R.O. Engrs.

C.O. (RF)

MONTHLY RECORD OF GAUGE READINGS AND WEATHER

BACK BAY

N. W. Refuge

Month

19

Date	Water Gauge Readings				Remarks						Precip	Temperature			Precipitation		
	Dock	"A"	"B"	"C"							Times	Max	Min	A/O	Rain	Snow	Total
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
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25																	
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27																	
28																	
29																	
30																	
31																	

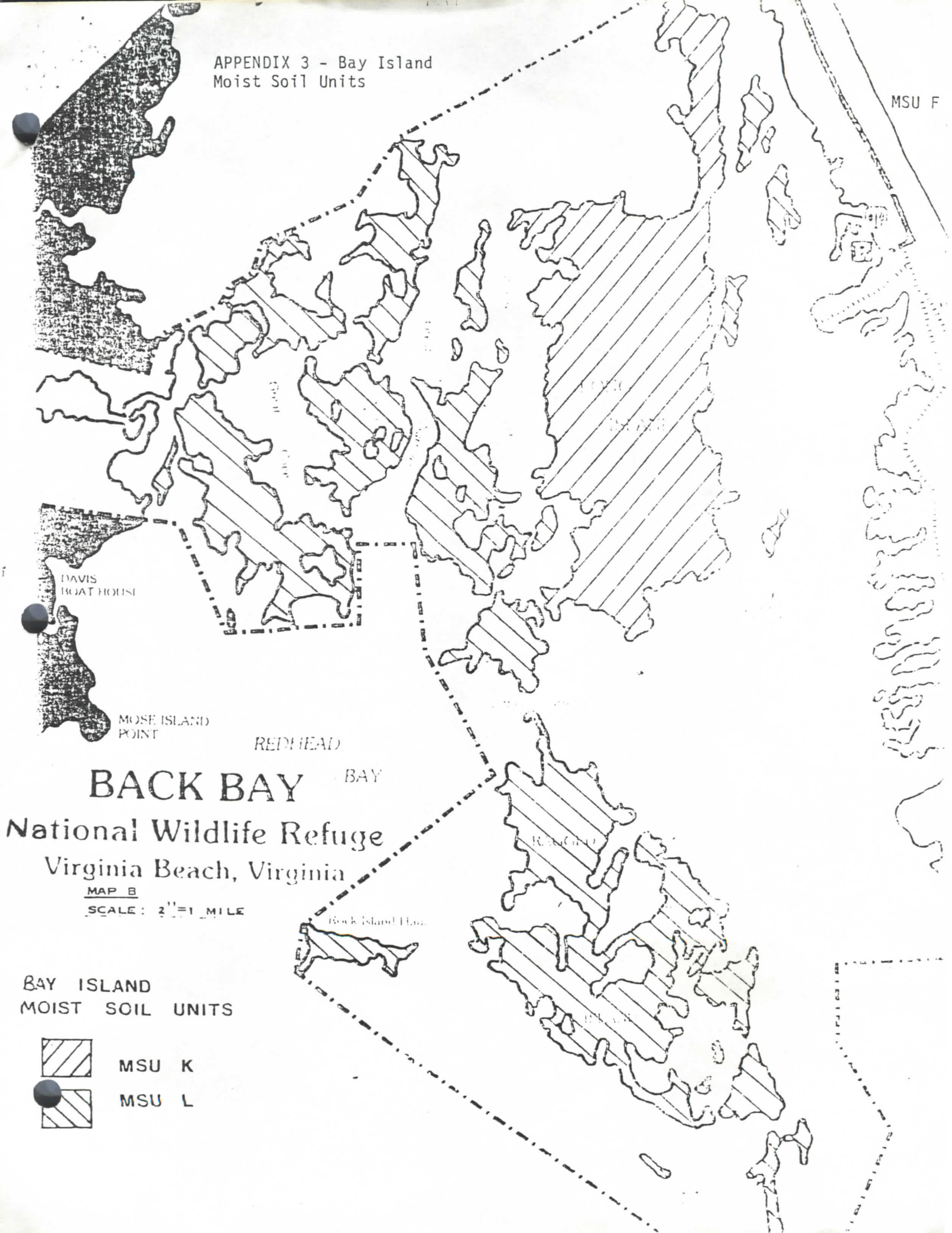
Water Management Unit Name or Number

1	8
2	9
3	10
4	11
5	12
6	13
7	14

Prepared by:

APPENDIX 3 - Bay Island
Moist Soil Units

MSU F



DAVIS
BOAT HOUSE

MOSE ISLAND
POINT

REDHEAD

BAY

BACK BAY

National Wildlife Refuge
Virginia Beach, Virginia

MAP B

SCALE: 2"=1 MILE

Rock Island Flats

BAY ISLAND
MOIST SOIL UNITS



MSU K



MSU L

BACK BAY

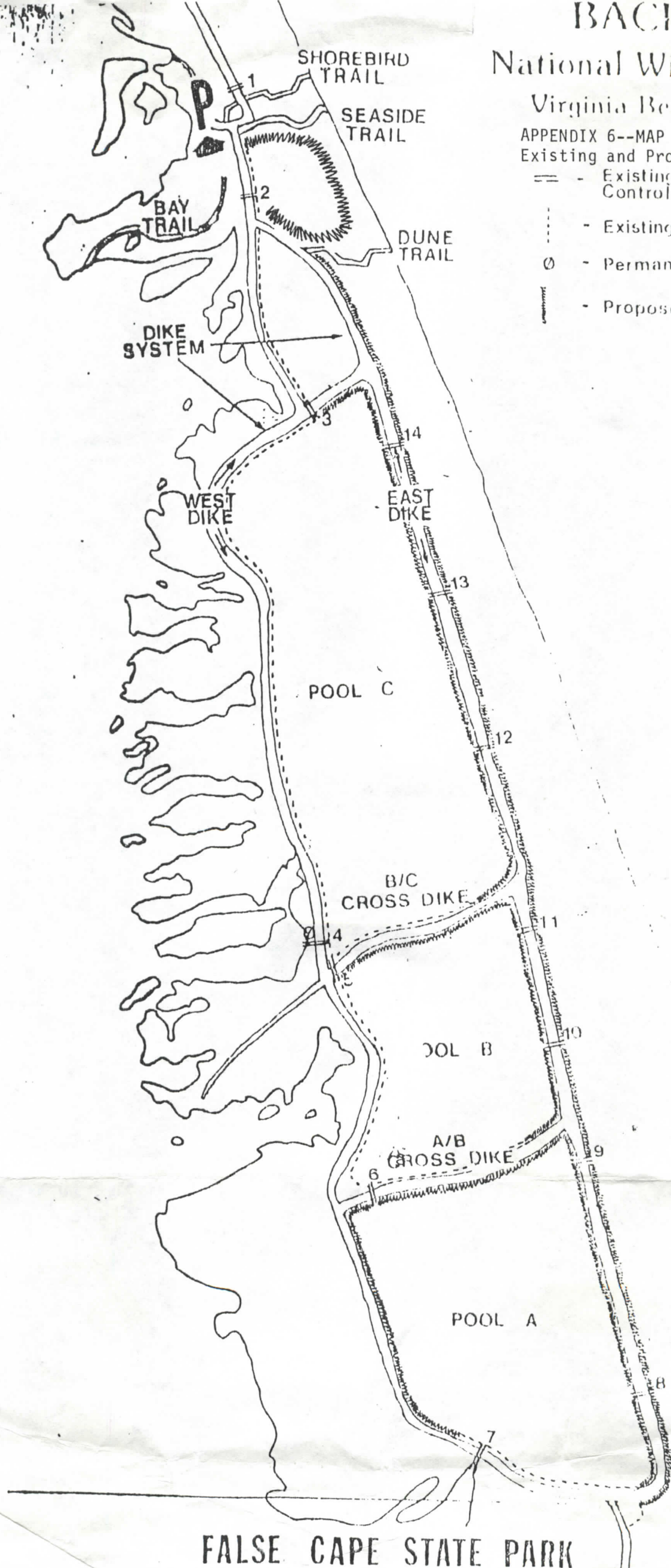
National Wildlife Refuge

Virginia Beach, Virginia

APPENDIX 6--MAP D.

Existing and Proposed Ditches

- == - Existing Water Control Structures
- - - Existing Ditches
- - Permanent Pump Station
- - - Proposed Ditches



APPENDIX 4 - BACK BAY REFUGE WETLAND
MANAGEMENT UNITS AND ACREAGE

POOL	TOTAL ACRES		TOTAL UPLAND		SWAMP WETLAND		EMERGENT WETLAND	
	#	%	#	%	#	%	#	%
A	221	- 100	40	- 18	15	- 7	166	- 75
B	114	- 100	2	- 2	3	- 3	139	- 96
C	240	- 100	34	- 14	---		206	- 86
D	17	- 100	13*	- 75	---		4*	- 25
E	25	- 100	10*	- 40	---		15*	- 60
F	75	- 100	23*	- 30	---		52*	- 70
G	88	- 100	18*	- 20	---		70	- 80^
H	76	- 100	8*	- 10	2*	- 2	66	- 88^
J	111	- 100	22*	- 20	33*	- 30	56	- 50^
<hr/>								
TOTALS	997	- 100	170	- 17	53	- 5	774	- 78
(* estimated)								

^ Planned - most of G, H, and J Pools presently consist of upland grasses and bayberry/waxmyrtle. At full plan implementation these areas, as well as some of the upland in A-E, will be converted to emergent wetlands.

MSU F

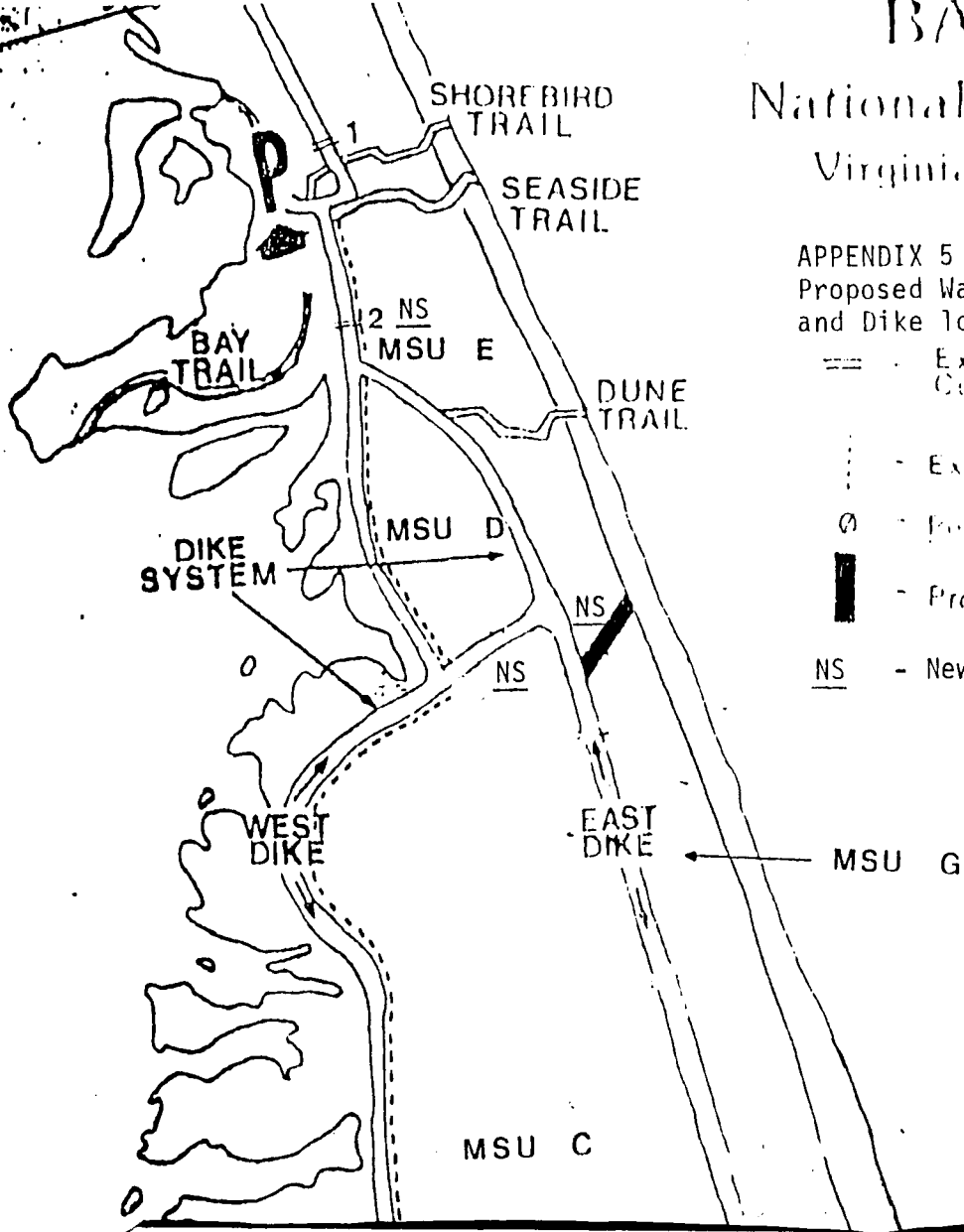
BACK BAY

National Wildlife Refuge

Virginia Beach, Virginia

APPENDIX 5 - MAP C Proposed Water Control Structures and Dike Locations

- == Existing Water Control Structure..
- - - Existing Ditches
- Ø Permanent Pump Station
- █ Proposed Dikes
- NS - New Structures (proposed)



BACK BAY

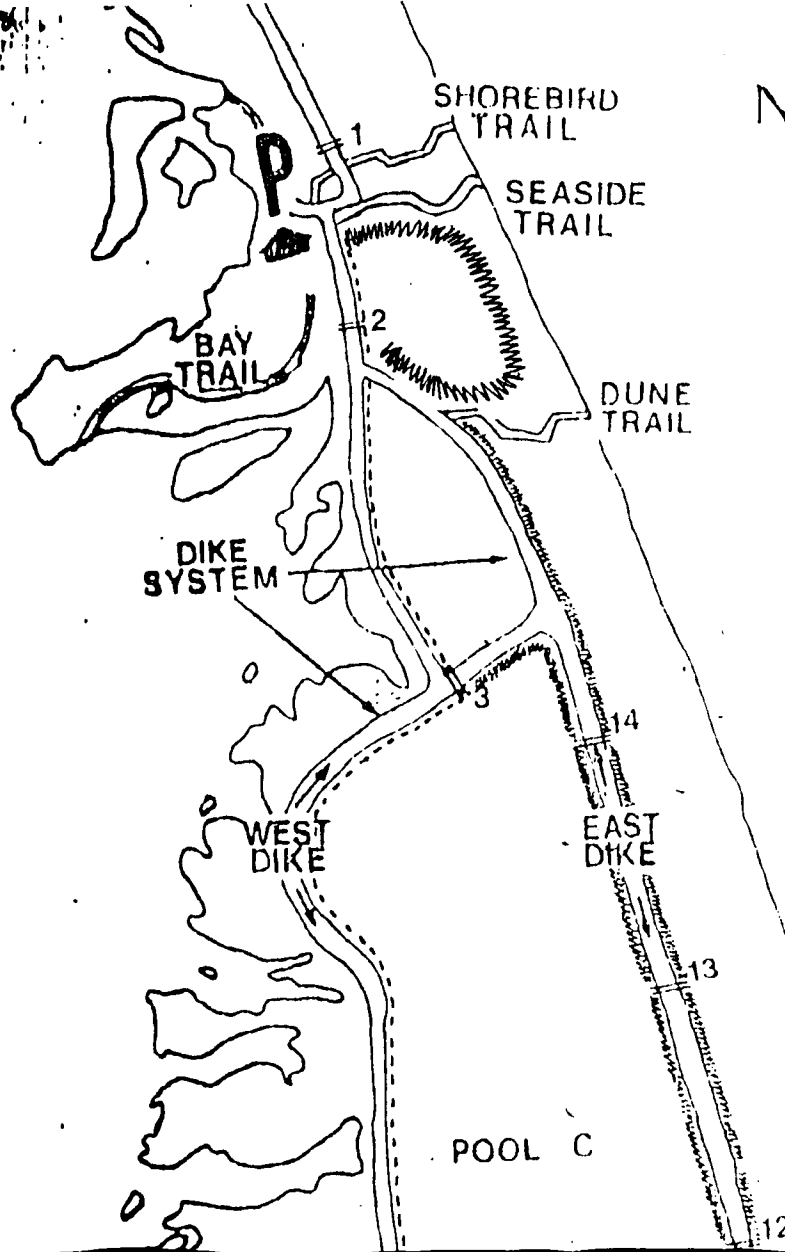
National Wildlife Refuge

Virginia Beach, Virginia

APPENDIX 6--MAP D.

Existing and Proposed Ditches

- == - Existing Water Control Structures
- - - Existing Ditches
- 0 - Permanent Pump Station
- - - Proposed Ditches



U.S. FISH AND WILDLIFE SERVICE
REFUGE MANUAL

HABITAT MANAGEMENT

6 RM 2 Exhibit 1

Annual Water Management Program Outline

Page 3

A POOL

A.1. Water Surface Elevations
and Salinity for Past Year (FY 88)

B.2. Planned Elevation and Salinity
for Program Year (FY 89)

Date	Water Surface Elevations	*Salinity (% of Sea Water)	Water Surface Elevation	*Salinity Objective
Jan. 1 --	1.9	N/A	2.1	5%
15 --	1.7	N/A	2.1	5%
Feb. 1 --	1.8	N/A	2.3	5%
15 --	1.9	N/A	2.3	5%
Mar. 1 --	1.7	N/A	2.3	5%
15 --	1.0	N/A	2.1	5%
Apr. 1 --	1.4	N/A	2.1	2%
15 --	1.8	N/A	2.1	2%
May 1 --	1.7	N/A	1.8	2%
15 --	1.9	N/A	1.8	2%
June 1 --	1.5	N/A	1.4	2%
15 --	1.4	N/A	1.4	2%
July 1 --	1.4	N/A	1.4	2%
15 --	1.6	N/A	1.4	2%
Aug. 1 --	1.6	N/A	1.5	2%
15 --	1.5	N/A	1.5	2%
Sept. 1 --	1.5	N/A	1.7	2%
15 --	1.6	N/A	1.7	2%
Oct. 1 --	1.4	N/A	1.7	2%
15 --	0.0	N/A	1.7	5%
Nov. 1 --	0.0	N/A	1.9	5%
15 --	1.0	N/A	1.9	5%
Dec. 1 --	1.1	N/A	1.9	5%
15 --	1.7	N/A	1.9	5%
31 --	1.5	N/A	2.1	5%

*To be used for pools approved for brackish water management.

0 = sea level

N/A = not available

Salinity objectives are maximums.

Release:

003 March 12, 1982

NATIONAL WILDLIFE REFUGE SYSTEM

U.S. FISH AND WILDLIFE SERVICE

REFUGE MANUAL

HABITAT MANAGEMENT

6 RM 2 Exhibit 1

Annual Water Management Program Outline

Page 3

B POOL

A.1. Water Surface Elevations
and Salinity for Past Year (FY 88)

B.2. Planned Elevation and Salinity
for Program Year (FY 89)

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15--	1.9	N/A	2.1	5%
Mar. 1--	1.7	N/A	2.1	5%
15--	1.5	N/A	1.9	5%
Apr. 1--	1.2	N/A	1.9	2%
15--	1.8	N/A	1.7	2%
May 1--	1.6	N/A	1.5	2%
15--	1.9	N/A	1.5	2%
June 1--	1.7	N/A	1.3	2%
15--	1.4	N/A	1.3	2%
July 1--	1.6	N/A	1.3	2%
15--	1.6	N/A	1.3	2%
Aug. 1--	1.6	N/A	1.5	2%
15--	1.4	N/A	1.5	2%
Sept. 1--	1.6	N/A	1.5	2%
15--	1.7	N/A	1.5	2%
Oct. 1--	1.3	N/A	1.7	2%
15--	1.3	N/A	1.7	5%
Nov. 1--	2.0	N/A	1.7	5%
15--	1.7	N/A	1.7	5%
Dec. 1--	2.1	N/A	1.9	5%
15--	2.1	N/A	1.9	5%
31--	2.0	N/A	1.9	5%

*To be used for pools approved for brackish water management.

0 = sea level

N/A = not available

Salinity objectives are maximums.

Release:

003 March 12, 1982

NATIONAL WILDLIFE REFUGE SYSTEM

U.S. FISH AND WILDLIFE SERVICE

REFUGE MANUAL

HABITAT MANAGEMENT

6 RM 2 Exhibit 1

Annual Water Management Program Outline

Page 3

C POOL

A.1. Water Surface Elevations
and Salinity for Past Year (FY 88)

B.2. Planned Elevation and Salinity
for Program Year (FY 89)

Date	Water Surface Elevations	*Salinity (% of Sea Water)	Water Surface Elevation	*Salinity Objective
Jan. 1--	2.0	N/A	1.9	5%
15--	1.8	N/A	2.1	5%
Feb. 1--	1.8	N/A	2.1	5%
15--	1.9	N/A	2.1	5%
Mar. 1--	1.7	N/A	2.1	5%
15--	1.5	N/A	1.9	5%
Apr. 1--	1.0	N/A	1.9	2%
15--	1.6	N/A	1.7	2%
May 1--	1.6	N/A	1.5	2%
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Nov. 1--	1.9	N/A	1.7	5%
15--	1.7	N/A	1.7	5%
Dec. 1--	2.0	N/A	1.9	5%
15--	2.1	N/A	1.9	5%
31--	1.9	N/A	1.9	5%

*To be used for pools approved for brackish water management.

0 = sea level

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Release:

003 March 12, 1982

NATIONAL WILDLIFE REFUGE SYSTEM

National Wildlife Refuge

Virginia Beach, Virginia

APPENDIX 2. MAP A.
PROPOSED MOIST SOIL UNITS

MSU F

SHORE BIRD
TRAIL

SEASIDE
TRAIL

DUNE
TRAIL

BAY
TRAIL

DIKE
SYSTEM

UNIT L

WEST
DIKE

EAST
DIKE

MSU C

B/C
CROSS DIKE

MSU B

A/B
CROSS DIKE

MSU A

FALSE CAPE STATE PARK

== - Existing Water
Control Structure..

- Existing Ditches

Ø - Permanent Pump Station

FORE DUNE LINE

BACK DUNE
LINE

MSU H

MSU J